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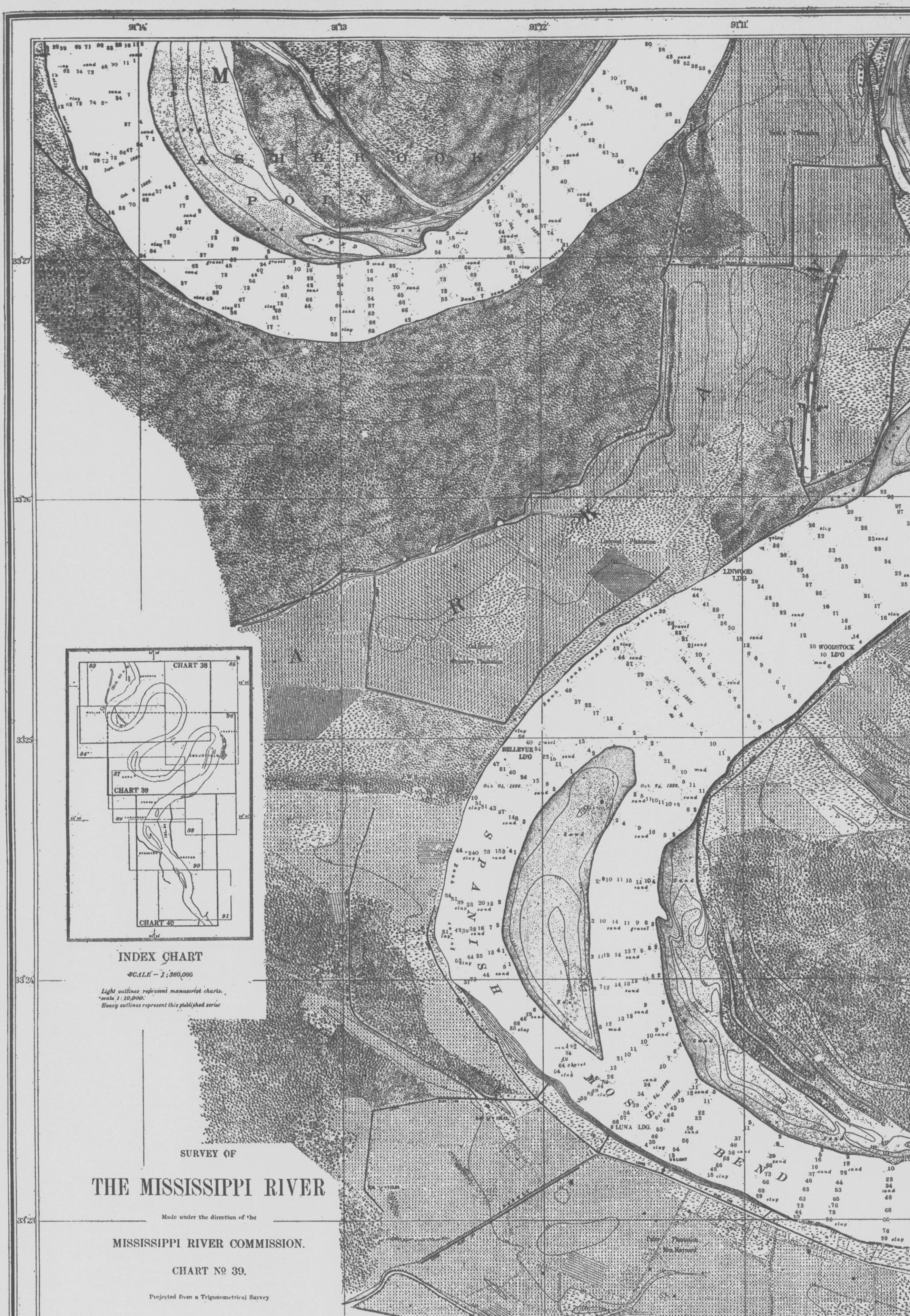


INDEX CHART

SCALE – 1:360,000

Light outlines represent manuscript charts, scale 1:10,000.
Heavy outlines represent this published series

SURVEY OF

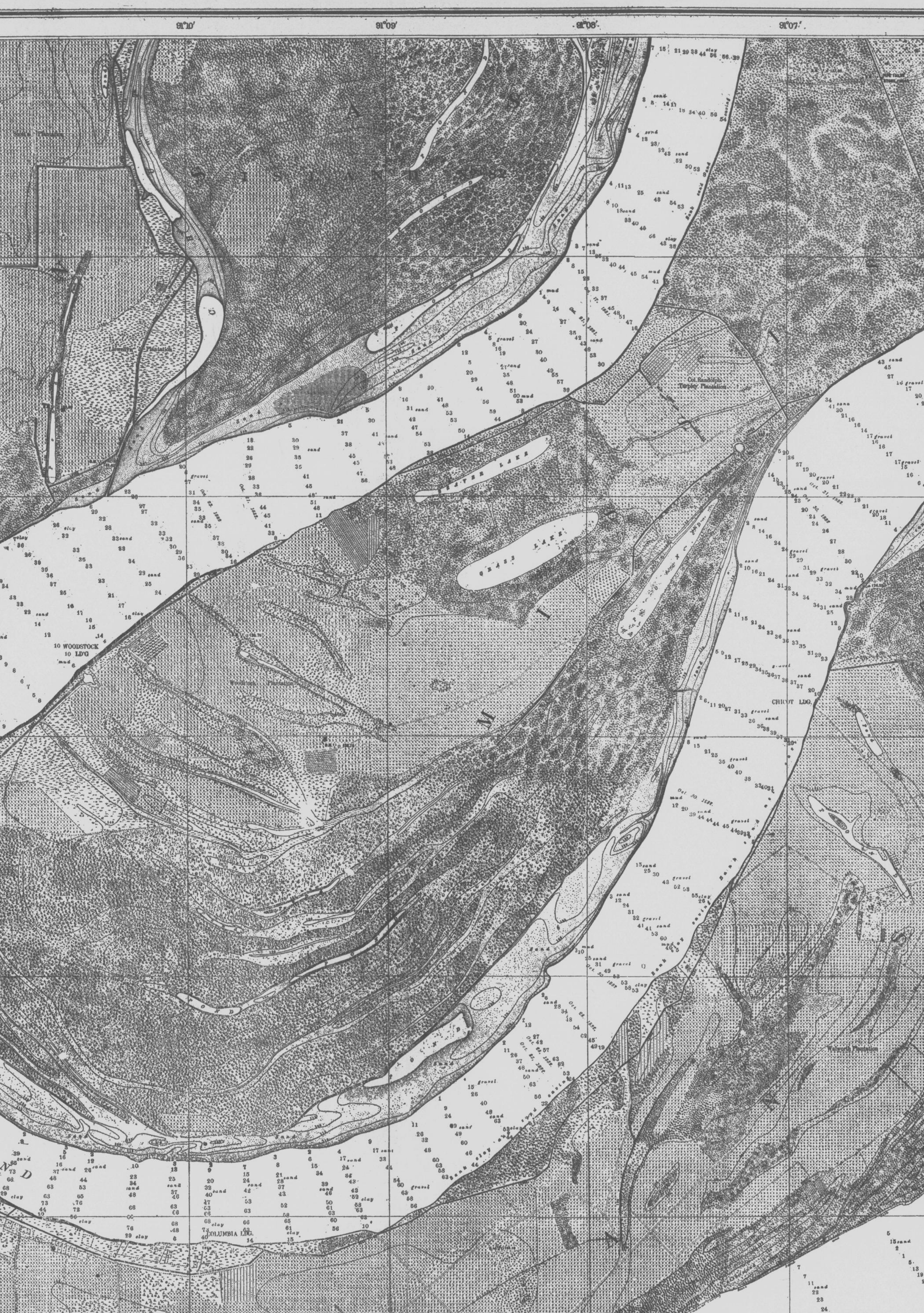
THE MISSISSIPPI RIVER

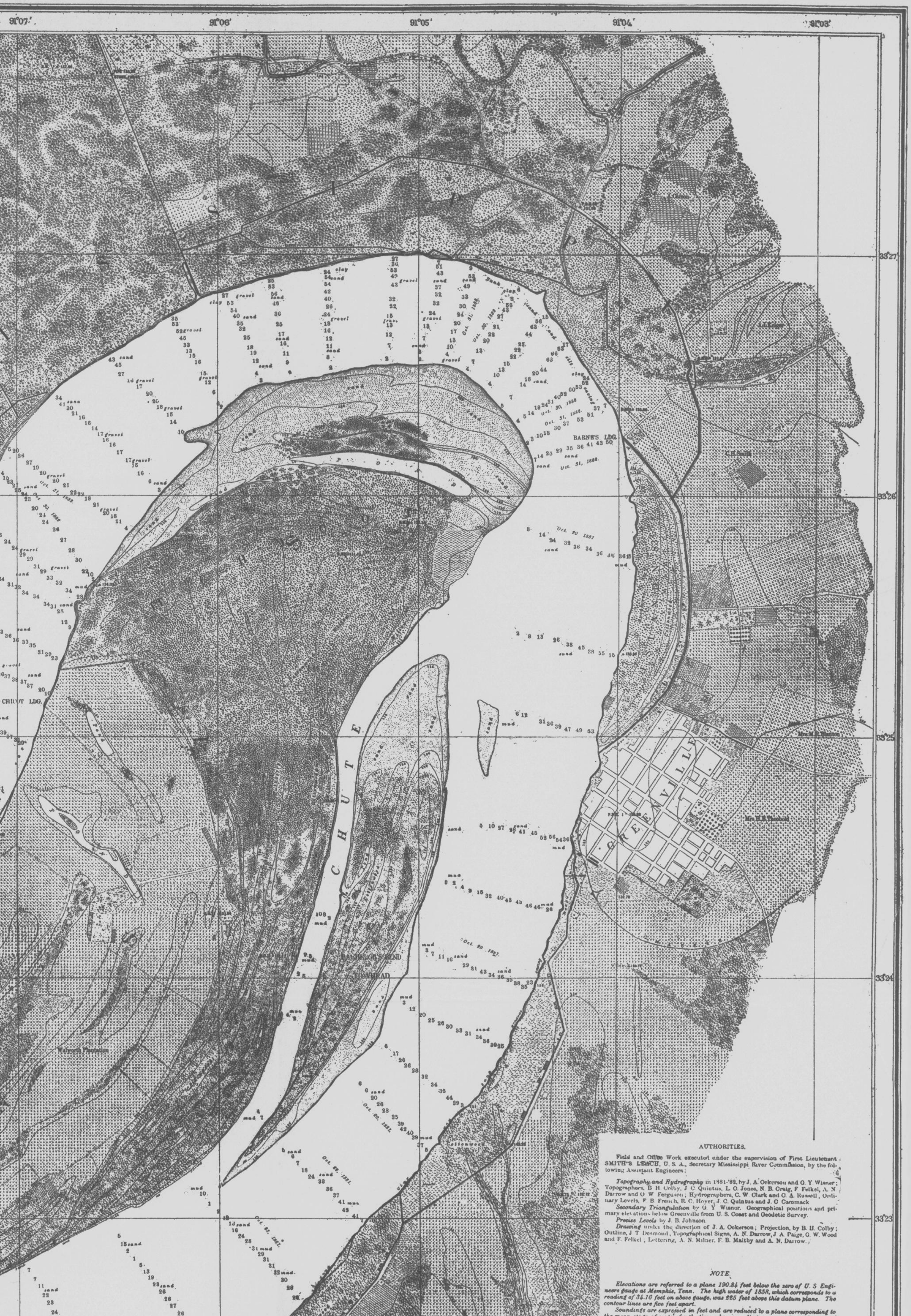
Made under the direction of the

MISSISSIPPI RIVER COMMISSION.

CHART No 39.

Projected from a Trigonometrical Survey


91°10'
91°09'
91°08'
91°07'
LOUISIANA
MISSISSIPPI
BEAVER LAKE
GRASS LAKE
Col. Randolph Turpley Plantation
WOODSTOCK LDG
CHICOT LDG.
COLUMBIA LDG.
Woodstock Plantation
Oct. 31, 1882
Oct. 30, 1882
Oct. 28, 1882
sand
gravel
mud
clay



AUTHORITIES.

Field and Office Work executed under the supervision of First Lieutenant SMITH S. LEACH, U. S. A., Secretary Mississippi River Commission, by the following Assistant Engineers:

Topography and Hydrography in 1881-'82, by J. A. Ockerson and G. Y. Wisner; Topographers, B. H. Colby, J. C. Quintus, L. O. Jones, N. B. Craig, F. Felkel, A. N. Darrow and O. W. Ferguson; Hydrographers, C. W. Clark and O. A. Russell, Ordinary Levels, F. B. French, R. C. Hoyer, J. C. Quintus and J. C. Cammack

Secondary Triangulation by G. Y. Wisner. Geographical positions and primary elevations below Greenville from U. S. Coast and Geodetic Survey.

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NOTE.

Elevations are referred to a plane 190.84 feet below the zero of U. S. Engineers gauge at Memphis, Tenn. The high water of 1858, which corresponds to a reading of 34.16 feet on above gauge, was 225 feet above this datum plane. The contour lines are five feet apart.

Soundings are expressed in feet and are reduced to a plane corresponding to

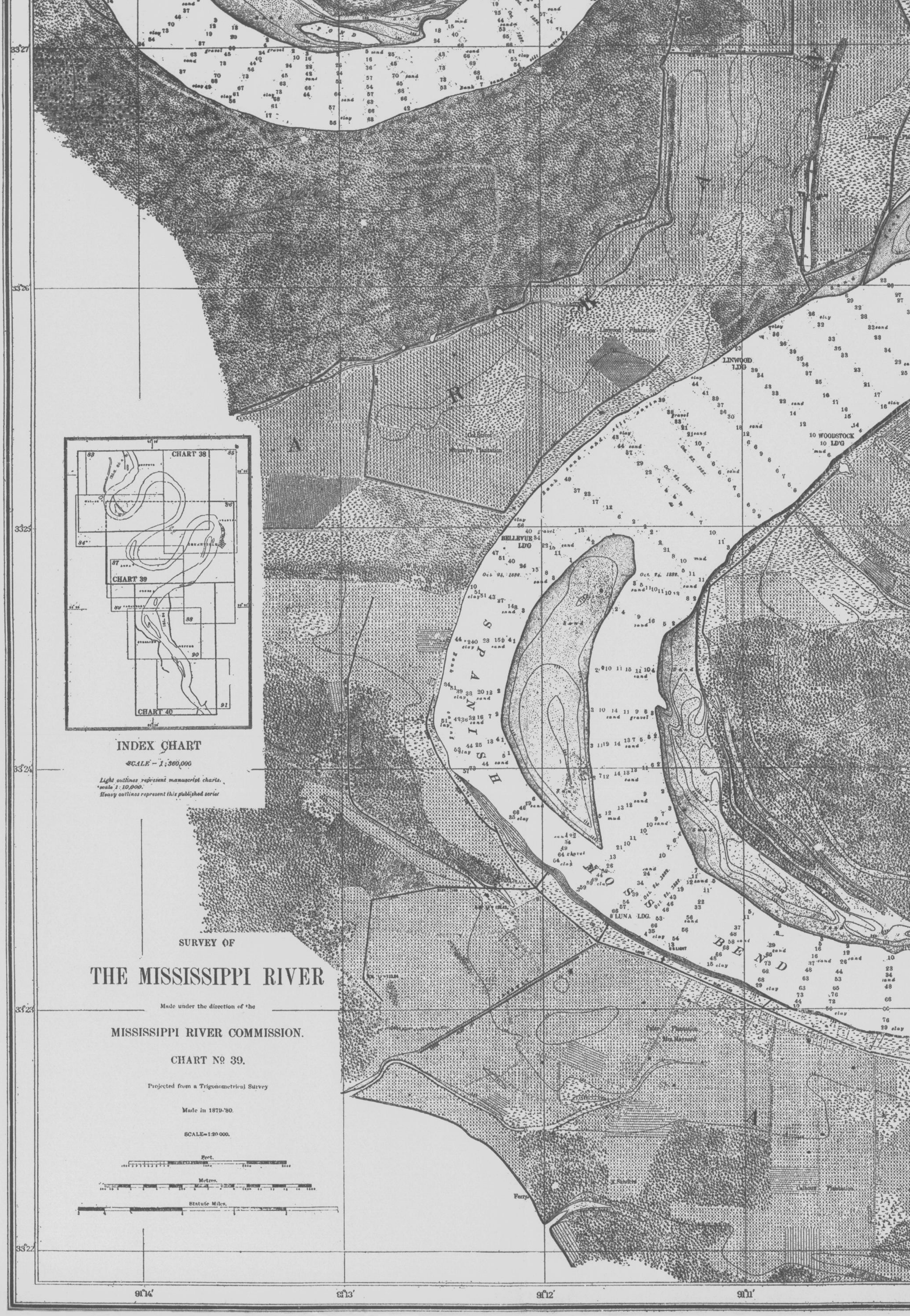
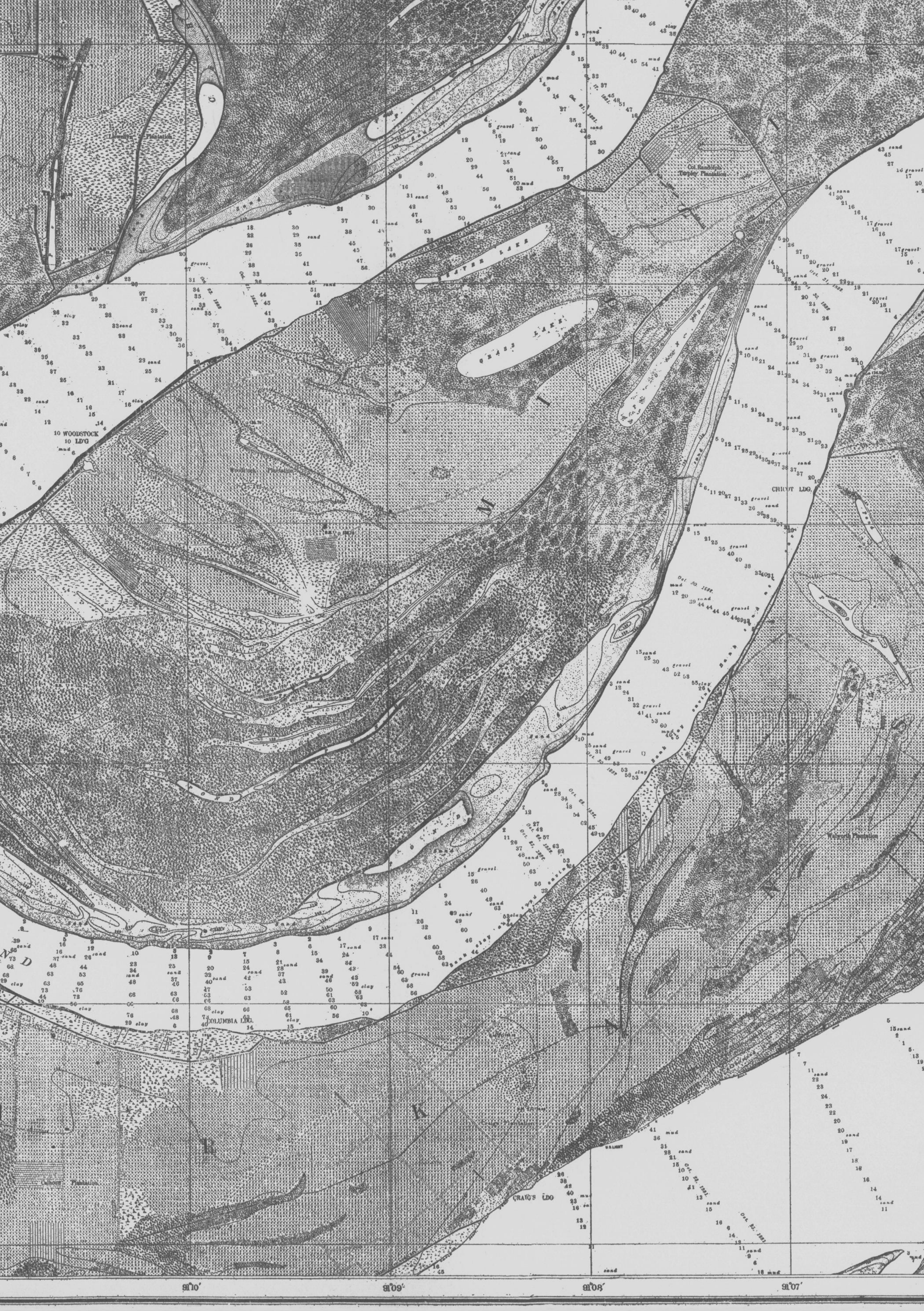

SURVEY OF
THE MISSISSIPPI RIVER
Made under the direction of the
MISSISSIPPI RIVER COMMISSION.
CHART № 39.
Projected from a Trigonometrical Survey
Made in 1879-'80.
SCALE=1:20 000.
Feet.
Metres.
Statute Miles.
INDEX CHART
SCALE – 1 : 360,000
Light outlines represent manuscript charts, scale 1 : 10,000.
Heavy outlines represent this published series
CHART 38
CHART 39
CHART 40
SPANISH MOSS BEND
BELLEVUE LDG
LINWOOD LDG
Linwood Plantation
WOODSTOCK LDG
LUNA LDG.
Calhoun Plantation
Ferry
33°27'
33°26'
33°25'
33°24'
33°23'
33°22'
91°14'
91°13'
91°12'
91°11'

FIG. 1.


WOODSTOCK LD'G
Col. Randolph Turpley Plantation
BEAVER LAKE
GRASS LAKE
CHICOT LDG.
COLUMBIA LDG.
CRAIG'S LDG
Calhoun Plantation
M
I
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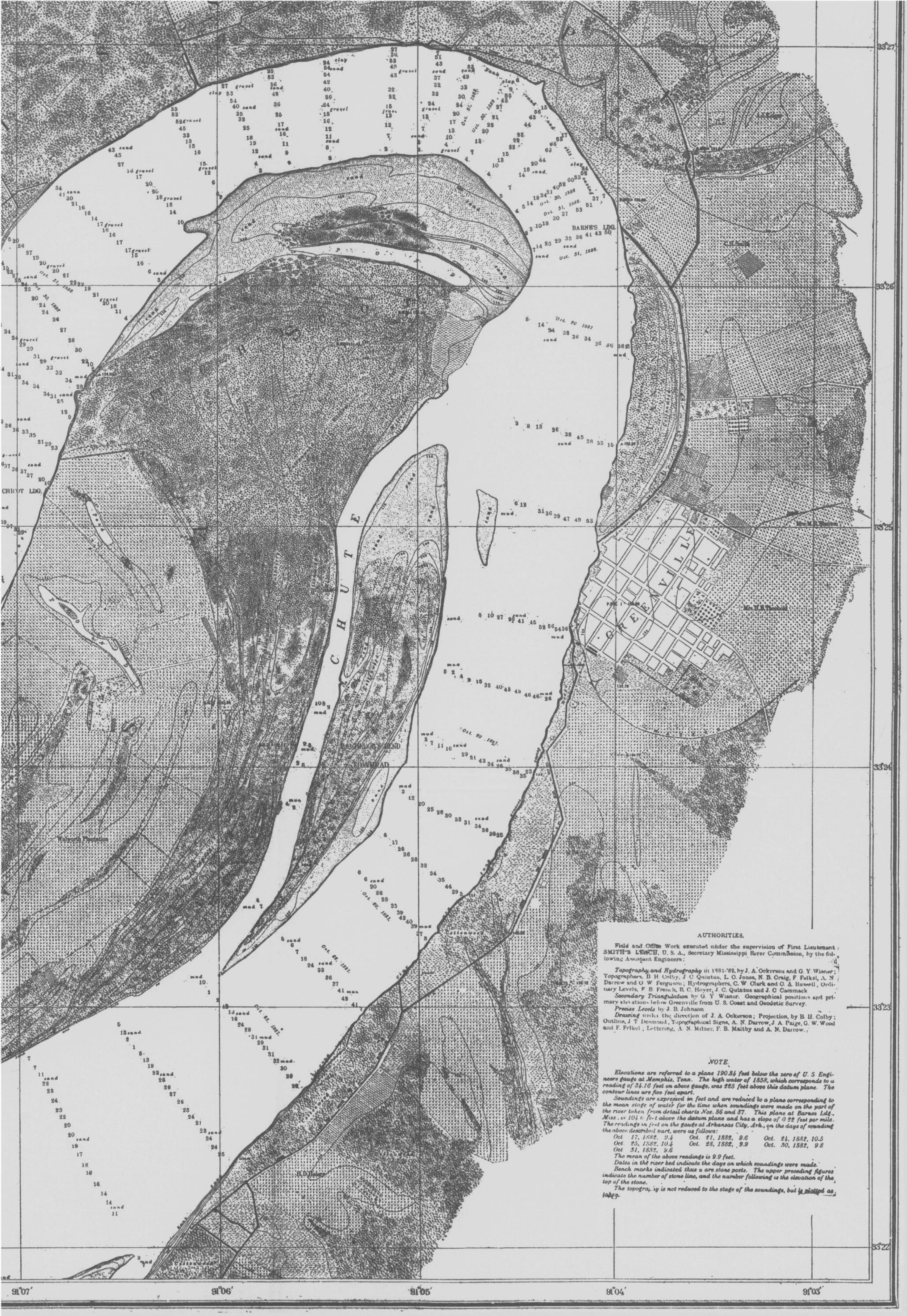
K
R
ND
91°10'
91°09'
91°08'
91°07'



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Soundings are expressed in feet and are reduced to a plane corresponding to the mean stage of water for the time when soundings were made on the part of the river taken from detail charts Nos. 86 and 87. This plane at Barnes Ldg., Miss., is 104.6 feet above the datum plane and has a slope of 0.22 feet per mile. The readings in feet on the gauge at Arkansas City, Ark., on the days of sounding the above described part, were as follows:

Oct. 17, 1882, 9.4 Oct. 21, 1882, 9.6 Oct. 24, 1882, 10.5
Oct. 25, 1882, 10.4 Oct. 28, 1882, 9.9 Oct. 30, 1882, 9.8
Oct. 31, 1882, 9.6

The mean of the above readings is 9.9 feet.

Dates in the river bed indicate the days on which soundings were made.

Bench marks indicated thus ◦ are stone posts. The upper preceding figures indicate the number of stone line, and the number following is the elevation of the top of the stone.

The topography is not reduced to the stage of the soundings, but is plotted as taken.

SURVEY OF

THE MISSISSIPPI RIVER

Made under the direction of the

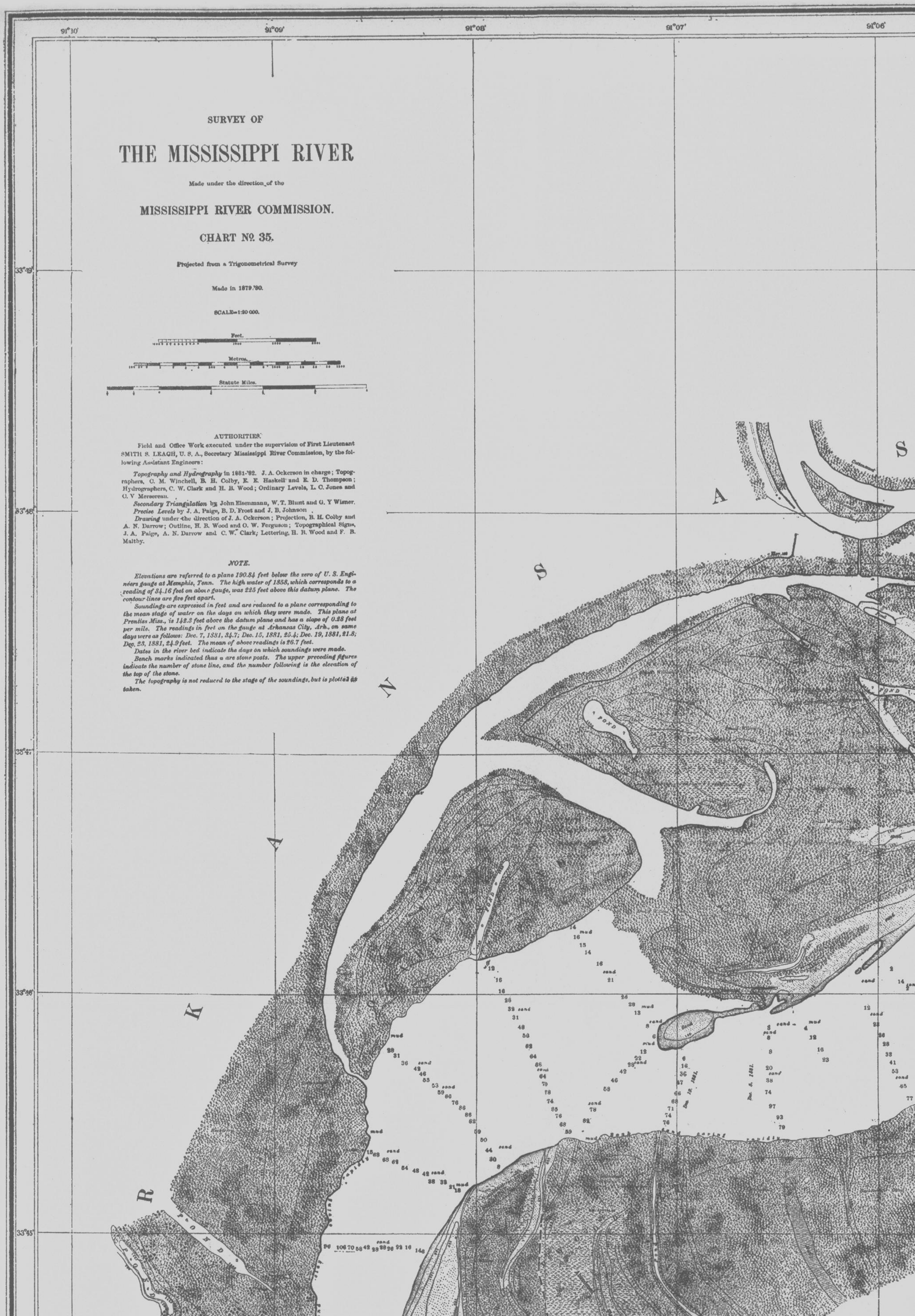
MISSISSIPPI RIVER COMMISSION.

CHART No. 35.

Projected from a Trigonometrical Survey

Made in 1879.'80.

SCALE=1:20 000.



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Secondary Triangulation by John Eisenmann, W. T. Blunt and G. Y Wisner.

Precise Levels by J. A. Paige, B. D. Frost and J. B. Johnson.

Drawing under the direction of J. A. Ockerson; Projection, B. H. Colby and A. N. Darrow; Outline, H. B. Wood and O. W. Ferguson; Topographical Signs, J. A. Paige, A. N. Darrow and C. W. Clark; Lettering, H. B. Wood and F. B. Maltby.

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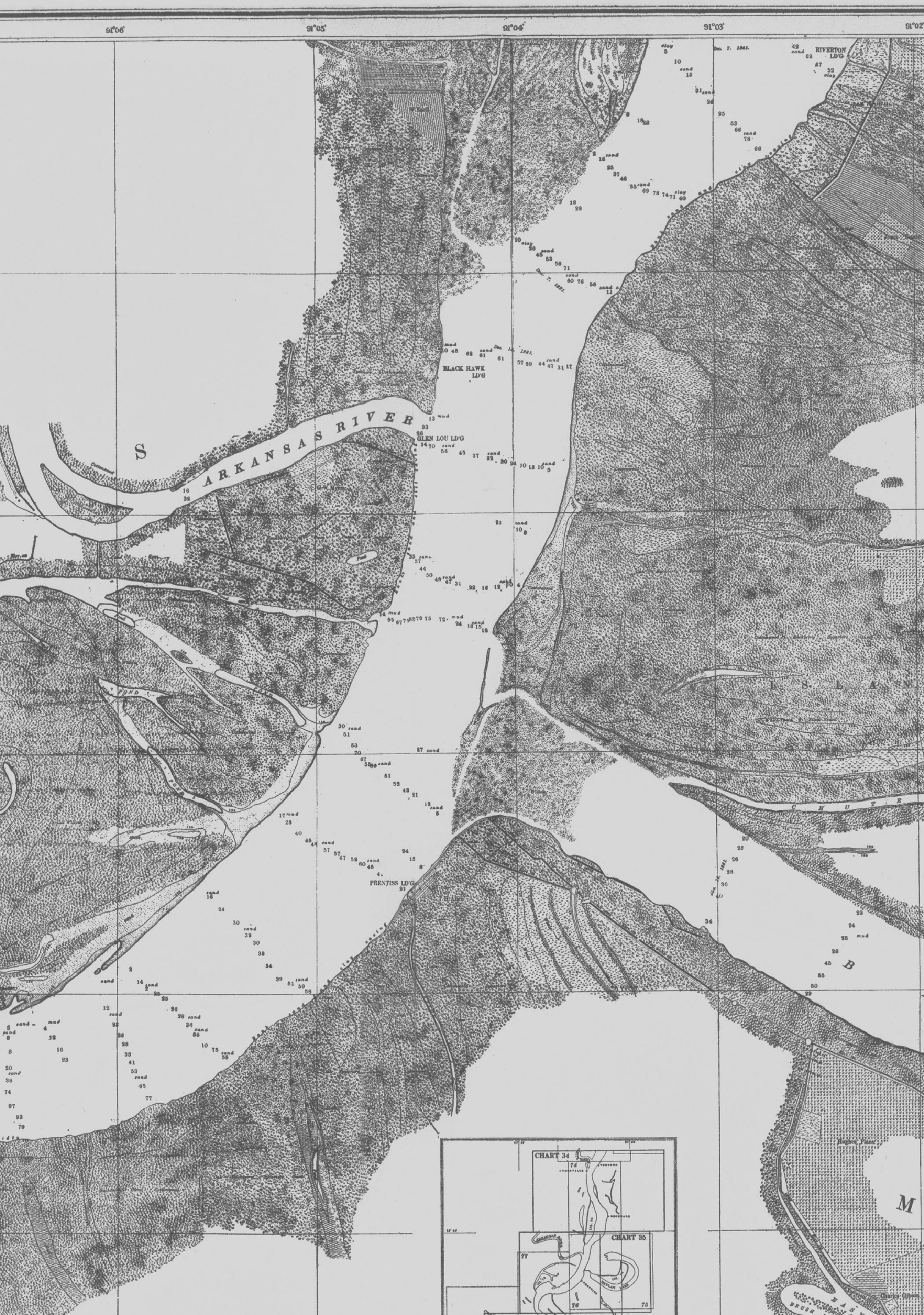
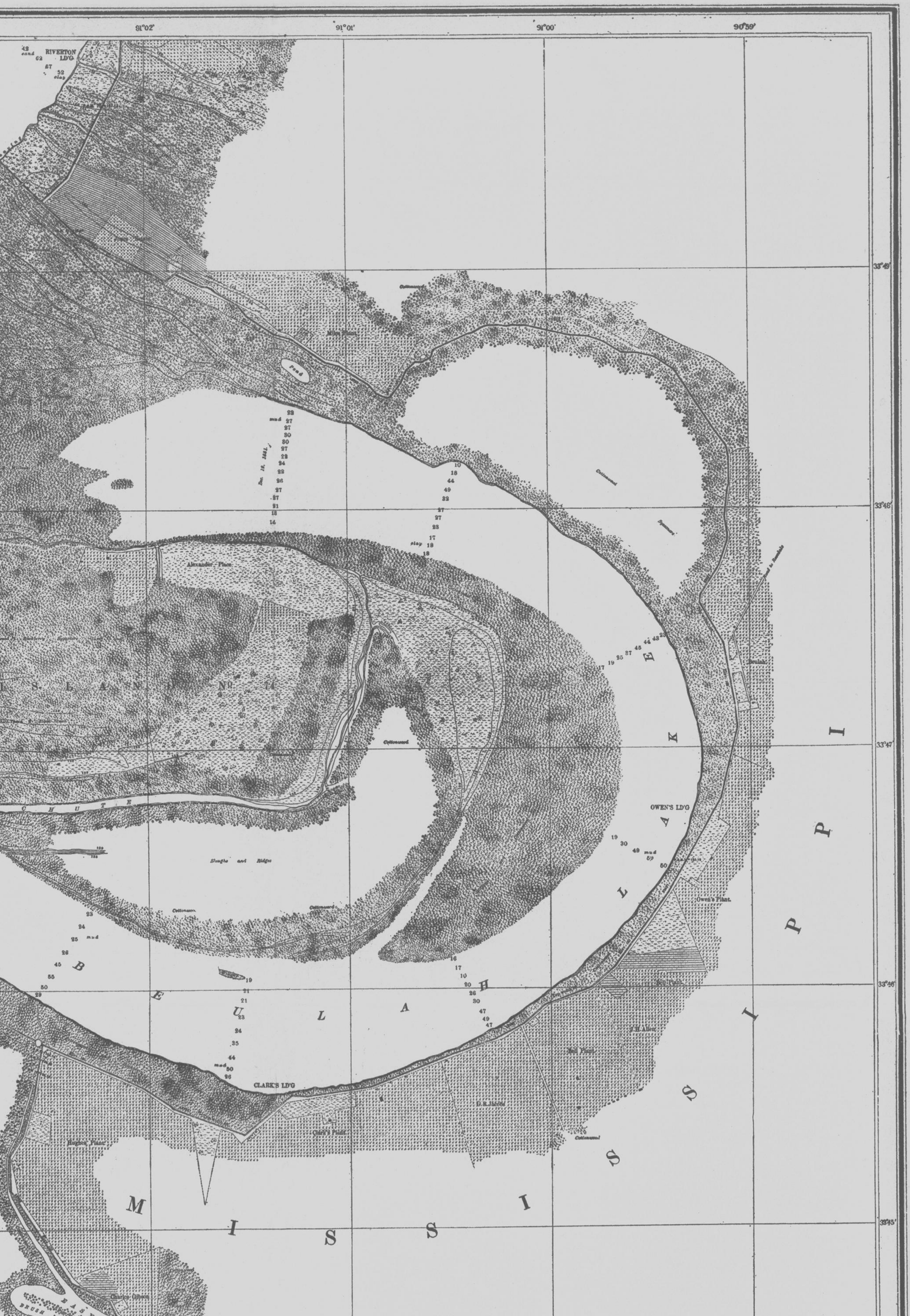
Soundings are expressed in feet and are reduced to a plane corresponding to the mean stage of water on the days on which they were made. This plane at Prentiss Miss., is 142.8 feet above the datum plane and has a slope of 0.28 feet per mile. The readings in feet on the gauge at Arkansas City, Ark., on same days were as follows: Dec. 7, 1881, 34.7; Dec. 15, 1881, 25.4; Dec. 19, 1881, 21.8; Dec. 23, 1881, 24.9 feet. The mean of above readings is 26.7 feet.

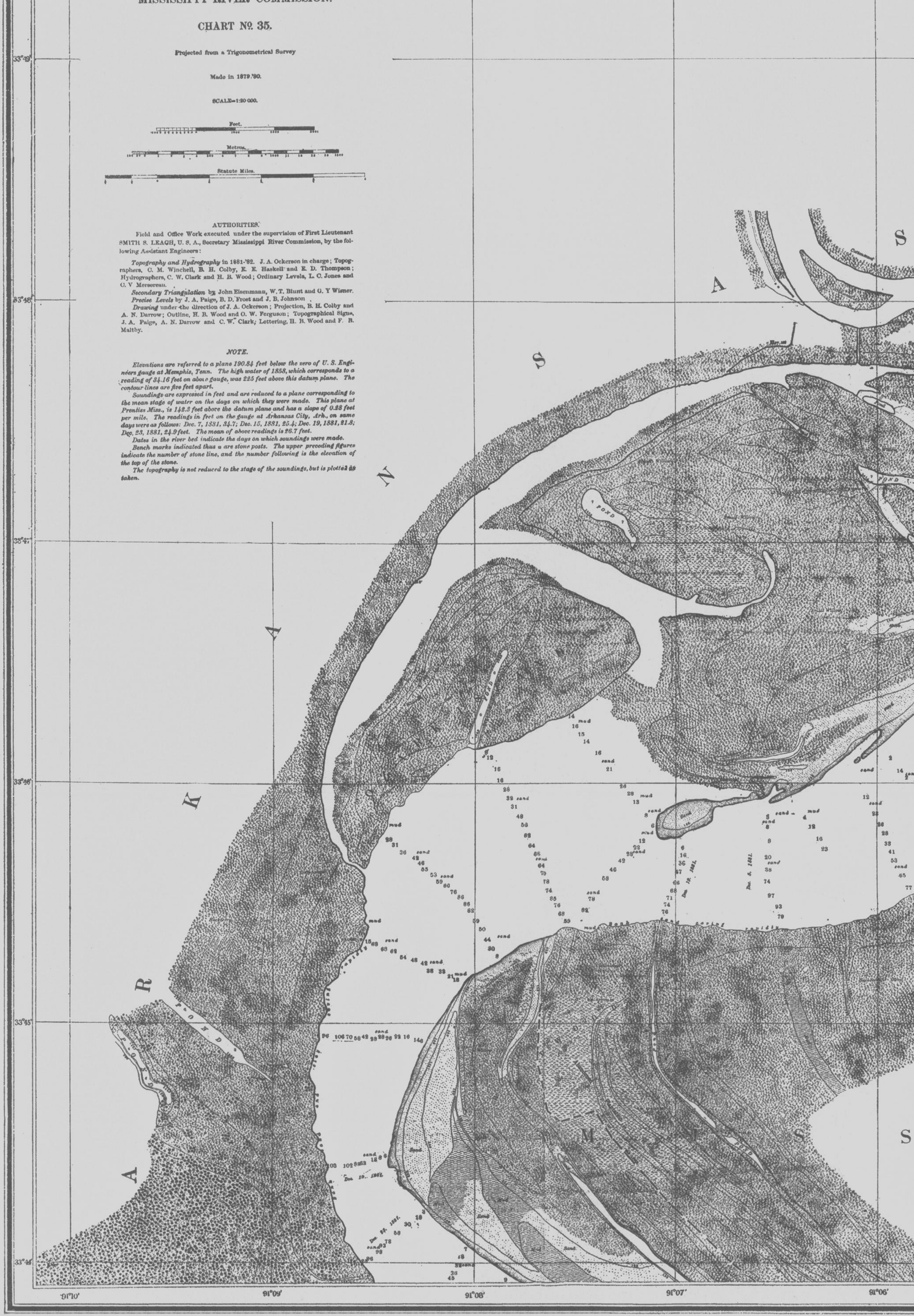
Dates in the river bed indicate the days on which soundings were made.

Bench marks indicated thus ▫ are stone posts. The upper preceding figures indicate the number of stone line, and the number following is the elevation of the top of the stone.

The topography is not reduced to the stage of the soundings, but is plotted as taken.


91°06'
91°05'
91°04'
91°03'
91°02'
ARKANSAS RIVER
S
RIVERTON LD'G
Dec. 7. 1881.
BLACK HAWK LD'G
Dec. 14. 1881.
GLEN LOU LD'G
PRENTISS LD'G
I S L A N
C H U T E
B
M
POND
Hugues Plant.
CHART 34
CHART 35
74
75
76
77

91°02'
91°01'
91°00'
90°59'
33°48'
33°48'
33°47'
33°46'
33°45'
RIVERTON LD'G
sand
clay
pond
Miles Plant.
Cottonwood
mud
clay
Sycamore
Road to Rosedale
Beulah
Alexander Place
ISLAND Nº 74
CHUTE
Sloughs and Ridges
Cottonwood
LAKE BEULAH
OWEN'S LD'G
Owen's Plant.
Bell Plant.
J. H. Allen
D. R. Jacobs
CLARK'S LD'G
Clark's Plant.
Hughes Plant.
Charles Gibson
EAST
BRUSH
MISSISSIPPI



MISSISSIPPI RIVER COMMISSION.

CHART Nº. 35.

Projected from a Trigonometrical Survey

Made in 1879-'80.

SCALE=1:20 000.

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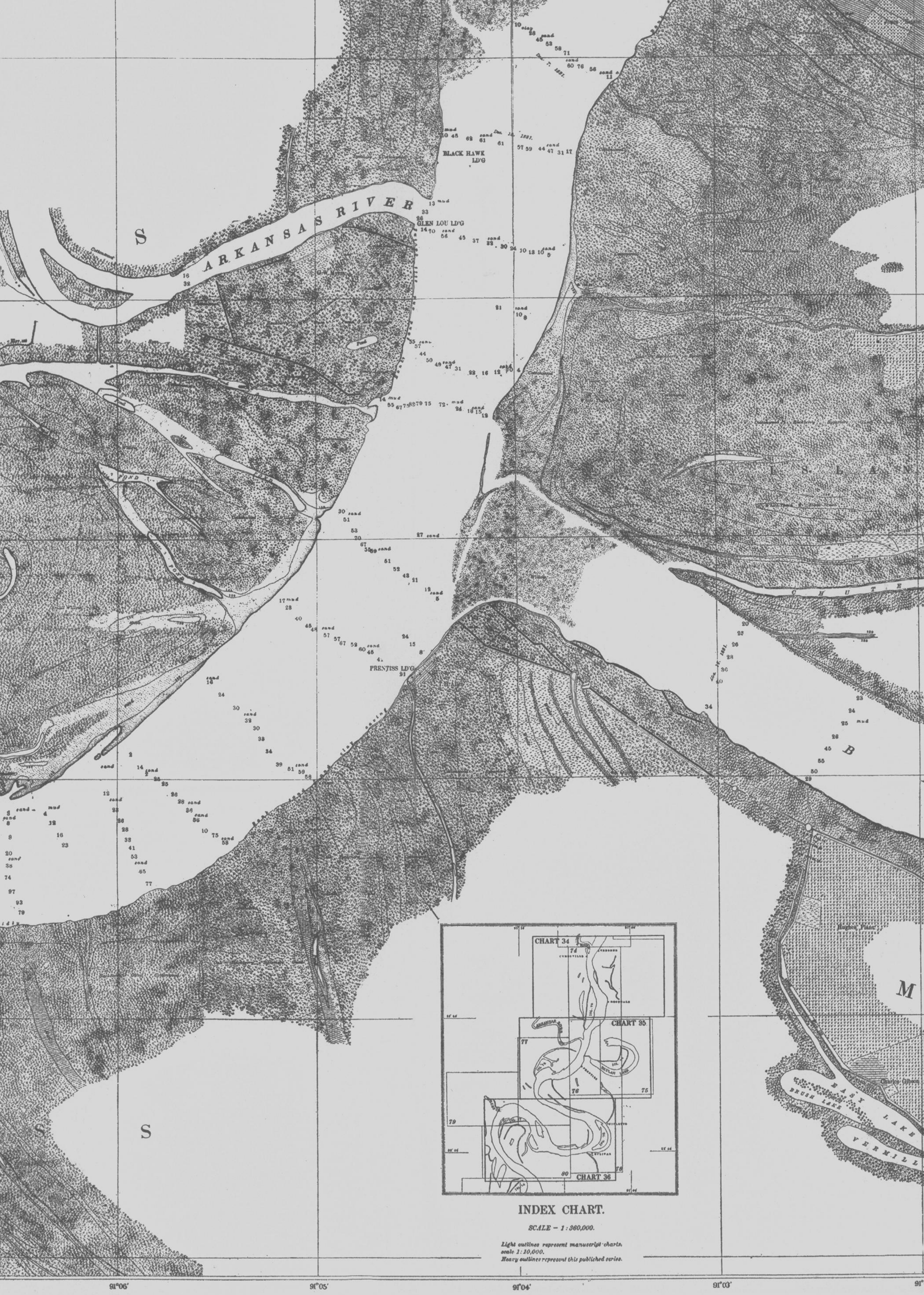
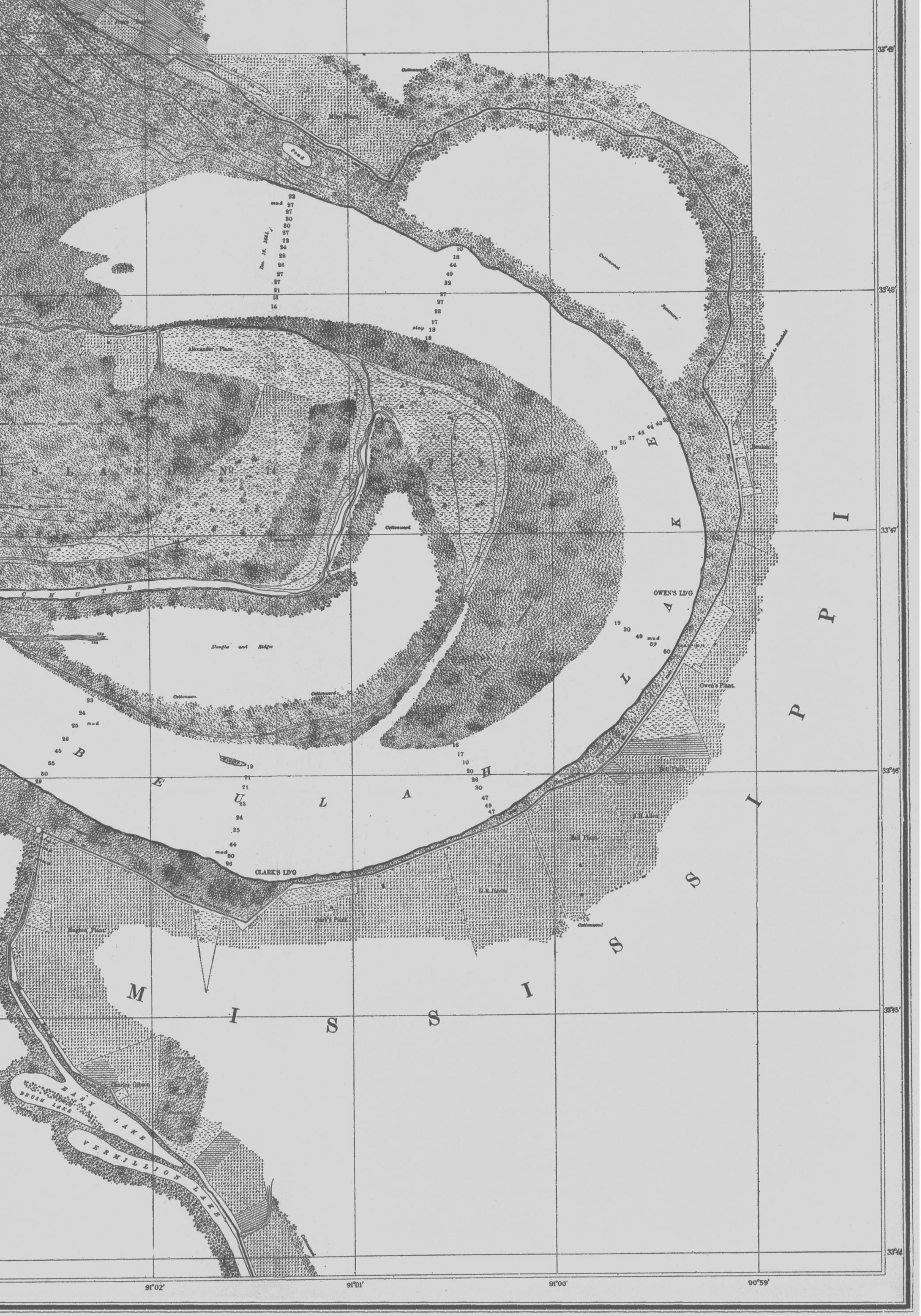
FIG. 2.



INDEX CHART.

SCALE – 1 : 360,000.

Light outlines represent manuscript charts, scale 1 : 10,000.
Heavy outlines represent this published series.


Miles Plant.
pond
Cottonwood
Dec. 18, 1881
mud
23 27 27 30 30 27 23 24 22 26 27 27 21 18 14
10 18 44 49 32 27 27 23 17 18 18
clay
Alexander Place
Cottonwood
Sycamore
Road to Rosedale
Beulah
ISLAND No. 14
CHUTE
Cottonwood
Slough and Ridges
Cottonwood
Cottonwood
17 19 25 37 45 44 43 23
OWEN'S LD'G
19 30 49 mud 59 50
Owen's Plant.
Bell Plant.
J. H. Allen
Bell Plant.
D. R. Jacobs
Cottonwood
23 24 mud 25 26 45 55 50 29
19 21 21 23 24 35 44 mud 50 26
16 17 10 20 26 30 47 49 47
BEULAH LAKE
CLARK'S LD'G
Clark's Plant.
Hughes' Plant.
MISSISSIPPI
Charles Gibson
EASY LAKE
BRUSH LAKE
VERMILLION LAKE
Cottonwood
33°49'
33°48'
33°47'
33°46'
33°45'
33°44'
91°02'
91°01'
91°00'
90°59'

BULLETIN

OF THE

AMERICAN GEOGRAPHICAL SOCIETY.

Vol. XXXI **1899.** **No. 1**

PHYSICAL GEOGRAPHY OF NEW YORK STATE.

BY

RALPH S. TARR.

PART VI.—LAKES AND SWAMPS.

ORIGIN.—A lake may be defined as a basin-shaped depression on the land, more or less completely filled with water. A depression along the sea shore, and partly connected with the ocean, is not commonly considered a lake, though when disconnected by the growth of a sand bar, such a body of water is often, and very properly, known as a pond or lake. Between pond and lake neither a popular nor a scientific distinction can be drawn, though, speaking very generally, the smaller bodies are ponds, the larger lakes.

A basin-shaped depression in the land surface is not a common production of the action of running water alone, although small basins of this origin are actually produced. For instance, a stream flowing over soluble rock, as limestone, very frequently dissolves tiny basins in that part of the stream bed where the rock material is most soluble. Again, the water at the base of a cataract frequently excavates a basin in which a deep pool stands, and this, with a change in direction of the river, or its removal for any other cause, may become a pond. (See p. 12).

Speaking generally, and bearing in mind such minor exceptions as these, it may be said that lake basins are rarely carved by the water that occupies them. Nevertheless, lakes may be considered to be parts of rivers, where locally, and for some cause, the normal slope of the river bed has been changed to a concave surface. There is such an exceedingly complex series of causes for these basins, that at first thought they would seem to defy an attempt at classification. One of the best attempts at such a classification is that by Davis,* in which origin is used as a basis. In this paper the general subject of the origin of lakes is discussed, and numerous instances cited for the various classes. In a later note † Davis proposed to substitute another basis for lake classification, considering them as parts of rivers changed to basins either as a result of accident or in the course of normal river development. It is that idea of Professor Davis which is followed in this brief consideration of New York lakes.‡

ORIGINAL CONSEQUENT LAKES.—In any *new land* surface, of whatever origin, basin-shaped depressions may exist. If the water supply were sufficient, lakes would fill the depressions, and these, being consequent on the initial or original topography, may be called *original consequent lakes.* For instance, the deposits that are now being made upon the sea bottom are not being laid down with perfect uniformity, so that numerous basins exist there. Illustrations of such basins are found in large numbers in the lakes of the Florida Everglades region, which is a raised sea bottom. There are now no instances of this class in New York, though when the plains were raised at the close of the Palæozoic, there must have been such depressions.

Very similar to these basins are those formed on the beds of lakes by irregularity of the sediment deposit. When for any reason the lake waters recede, these basins become independent lakes. There is a rim of old lake bottom around the shores of Lakes Erie and Ontario in which there are numerous ponds and lakes, some of which are in original consequent basins in the constructional lake bottom topography.

A surface constructed by any other means may possess original irregularities. For example, the surface of a lava flow may be irregular, though of this class no examples would be expected in this State. They abound, however, in regions where lava flows have recently occurred. Ponds not uncommonly gather in the crater-shaped depressions amidst sand dunes, as along the Long Island shore. We find abundant illustrations of original consequent lakes in the depressions existing in beds of till, or moraine, or stratified gravel,§ or other deposits resulting directly or indirectly from the glacial invasion. Still another class of original lake is that which must have existed on the surface of the ice itself when it covered the State. These temporary ice-surface lakes are common on the Greenland ice sheet to-day.

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* Proc. Boston Soc. Nat. Hist., 1880–82, XXI, 315–381.

† Science, 1887, X, 142.

‡ For an excellent discussion of lakes see Russell, Lakes of North America, Ginn & Co., 1895.

§ Fairchild, Journ. Geol., 1898, VI, 589–596.

LAKES OF NORMAL DEVELOPMENT.—By these are meant those which are formed in the course and as the result of the normal development of rivers. Two instances of these have been mentioned above (p. 1); and another, similar to them because of its direct relation to the existing stream bed, is the tiny basin so often caused by the irregularity of *deposit* in the stream bed. One sees this particularly well illustrated in the semi-arid regions, as in Central Texas, where, during the dry season, the stream bed becomes transformed to a series of dry bars with ponds between. So marked is this feature that it has come to be symbolized on the topographic maps, where such intermittent streams are marked by a dotted line.

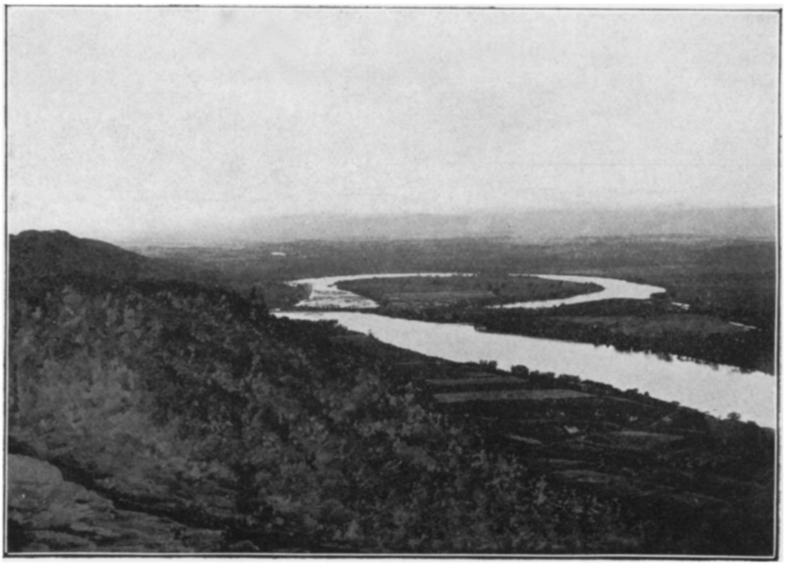

FIG. 3.—OX-BOW-CUT-OFF LAKE IN CONNECTICUT VALLEY, NORTHAMPTON, MASS.

A larger illustration of lakes of normal development may be found upon floodplains. Such a plain is the direct result of the normal development of a river and in the course of its formation the stream that builds it meanders about over it, frequently abandoning one curve and commencing another. In this way a second channel is carved in the floodplain; and the first being separated from the main stream, then becomes a true lake, the dam separating it being river floodplain deposit. Such lakes are strikingly developed on the Mississippi River floodplain (Figs. 1 and 2), where, in some cases, they have the shape of perfect meanders or ox-bow curves. If cut off by a change in the river, they are known as ox-bow-cut-off lakes (Fig. 3). On the floodplains of many of the large and small streams of New York this class of lake is well illustrated by linear ponds in which all stages of separation from the main stream are found.

Where streams have built deltas the irregular growth of the delta front, combined with the action of the waves, often forms ponds or lakes. These are admirably illustrated on the growing Mississippi Delta by some of the large lakes, which are entirely inclosed, and by some of the arms of the sea which are partly inclosed. The same cause operates in the growth of lake deltas; and ponds of this type are common on the deltas which are being built in the New York lakes (Fig. 4).

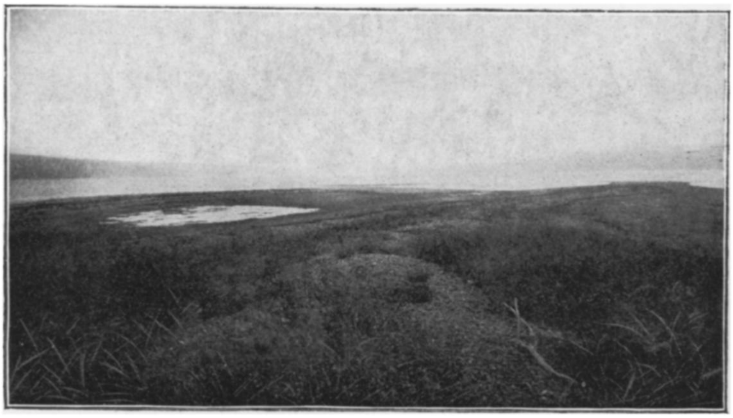

FIG. 4.—POND FORMED BY IRREGULAR GROWTH OF DELTA, LUDLOWVILLE, N. Y. (C. S. DOWNES. PHOTOGRAPHER).

By the deposit of sediment in river courses, lakes and lake-like expanses may be caused. For instance, the Mississippi River, above the mouth of the Chippewa, is transformed to a quiet body of water known as Lake Pepin. This quiet stretch, which is *called* a lake, is the result of a dam built of sediment brought down by the Chippewa and deposited in the Mississippi, which was unable to carry it further. Tiny illustrations of this same condition are found in this State.

The growth of sand and gravel bars across bays at the mouths of rivers often transforms them to true lakes. One may see numerous illustrations of this along the shores of Lakes Ontario and Erie, and also along the Long Island coast. Here there is every gradation between the open bay and the lake caused by complete closure (Figs. 5 and 6).

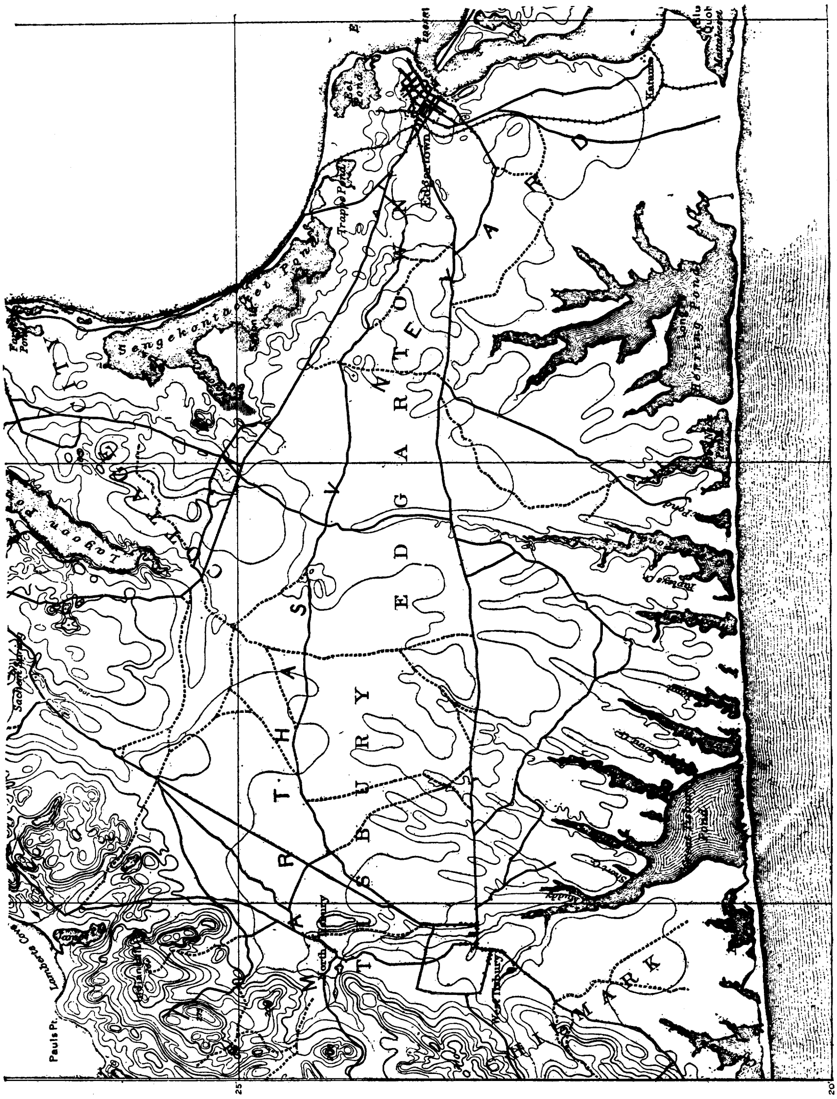

FIG. 5.—PONDS FORMED BY SAND BARS ACROSS THE MOUTH OF BAYS, MARTHA'S VINEYARD, MASS. (U. S. GEOLOGICAL SURVEY TOPOGRAPHIC MAP).

In the course of the normal development of certain streams peculiarly located the drainage may become underground. This is particularly liable to be the case in limestone regions where the water dissolves an underground channel for itself. In places this

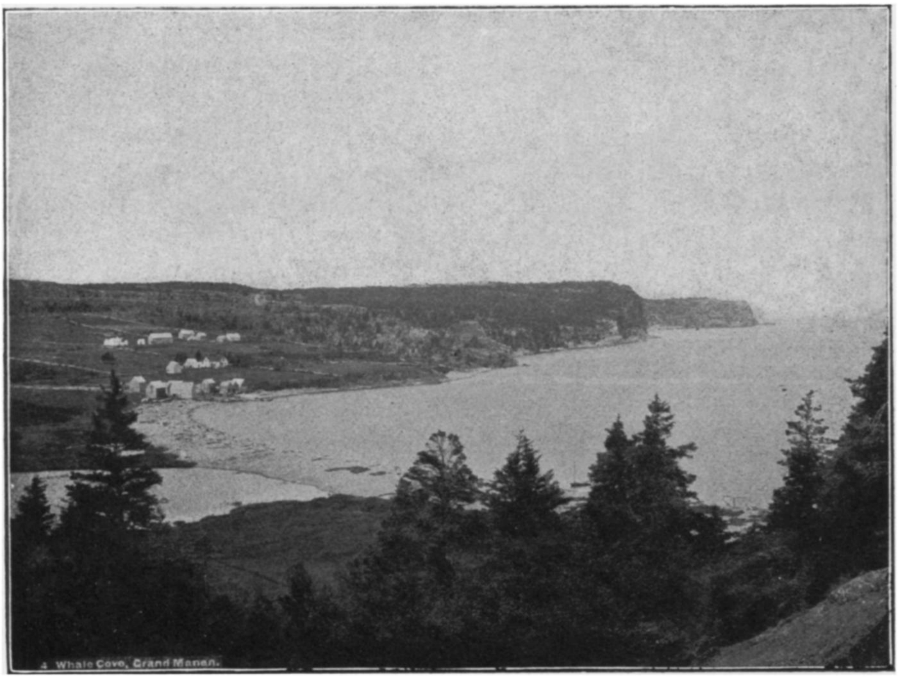

FIG. 6.—A BAR SHUTTING IN A POND, GRAND MANAN.

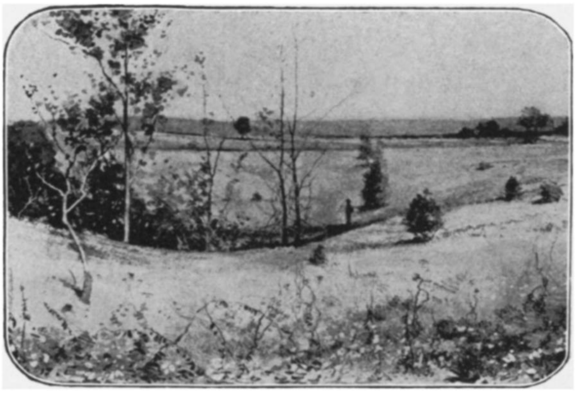

FIG. 7.—A SINK HOLE IN THE LIMESTONE REGION OF KENTUCKY.

causes a settling of the surface, forming sink-holes (Fig. 7) in which lakes often gather (Fig. 8). The removal of any soluble substance, as salt, may cause the same kind of basin. While lake basins of solution origin are very common in places, few have been discovered in New York. There are illustrations of this class of lake near Union Springs on the shore of Lake Cayuga.

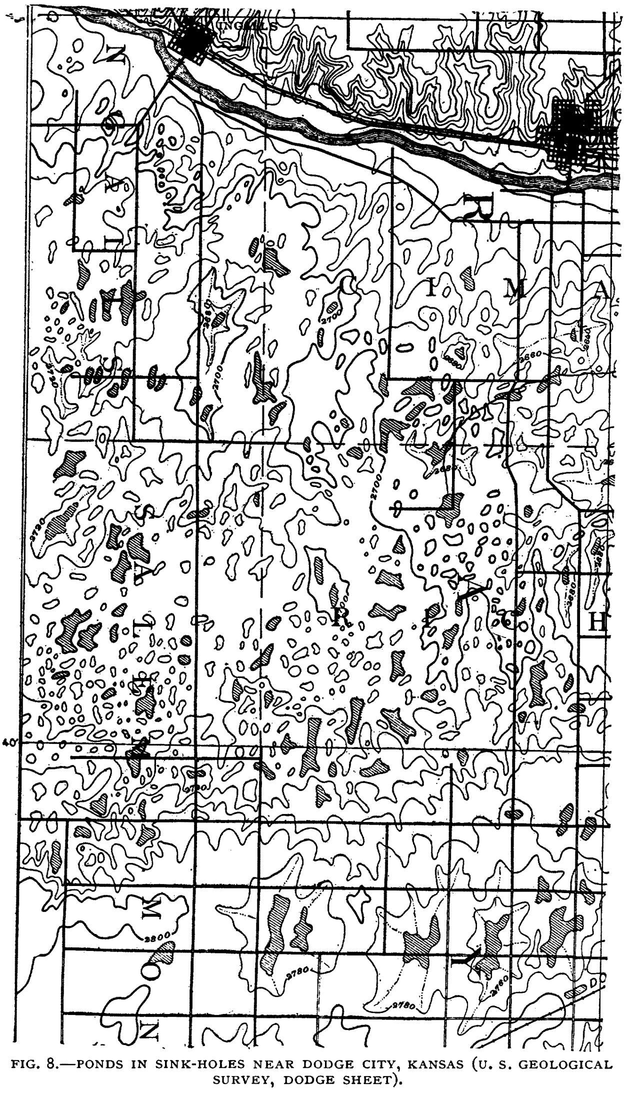

FIG. 8.—PONDS IN SINK-HOLES NEAR DODGE CITY, KANSAS (U. S. GEOLOGICAL SURVEY, DODGE SHEET).

Lakes Due to Accident.—One of the most common ways in which river slopes have been locally changed to basins is by the development of some dam across a river course. Such dams are commonly due to some accident by which the normal development of the river has been interrupted. For instance, the early settlers of New York found hundreds of ponds and swamps caused by the dams thrown across small streams by beavers. Some of these still exist, and in parts of the continent, as in Canada and the Rocky Mountains, beaver dams are even now being constructed.

A landslide or an avalanche may obstruct a stream course and transform it to a lake. Among lofty mountains, as in the Himalayas, vast dams of fallen rock have formed good-sized lakes, and in New York there are instances, though very much smaller.* The dams formed in New York are generally caused where a stream, eating at the base of a bank of glacial till, has caused a slide to occur, which has temporarily transformed the stream to a pond above the dam.

The movement of the earth's crust during mountain building oftentimes throws insurmountable barriers across stream courses. As the mountain chain rises higher and higher, it may so interfere with the drainage as to turn the stream far out of its original course. Among mountains of recent growth, lake basins due to this cause have been found, and still other illustrations are found in basins that have been drained. Doubtless lakes of this sort developed in the course of the formation of the mountains of eastern New York; but this was so long ago, and has been succeeded by such a complex series of changes, that every evidence of their existence has been erased.

To form lakes by crustal movement does not necessarily call for the growth of a mountain chain; a gentle warping of the crust may cause a broad hollow. Also, with a stream sloping moderately in a given direction, let us suppose northward, an elevation or tilting of the land, slightly greater in the north than in the south, may transform the stream valley to a lake basin. It seems certain that such lakes as Champlain and the Great Lakes owe at least a part of their present basin form to such great crust movements, of which there is excellent evidence.

But by far the greater number of the thousands of lakes upon the surface of New York, and northeastern America in general, have come into existence as the result of glacial accidents. In numerous ways the ice has been responsible for lakes. For instance, when the ice was withdrawn from New York, it obstructed and dammed most of the north-flowing streams.* Since many of the New York streams are north-flowing, this caused the development of numerous temporary lakes held behind the ice dam. The evidence of these, in the form of shore lines and deltas clinging to the hillsides, is found in various parts of the State. Even in some of the south-flowing streams there is evidence of similar conditions; for, as in the case of the Alleghany, some streams that originally flowed northward, were held in the form of lakes for a long enough period to cut new channels at the outlet and thus reverse the streams. By far the most marked evidence of these glacial lakes is found around the shores of the Great Lakes, which were raised by ice dams until they covered large areas that are now dry land, and found outlets quite different from those at present occupied.

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* Mather, Geol. Survey N. Y., 1st Dist., 1843, 32–37; 634–636; Dwight, A. J. S., 1866, 2nd Ser., XLI, 12–15.

As the result of glacial *deposit*, scores of thousands of lakes have been caused in North America. Before the ice came, there existed valleys occupied by streams. These were then submerged by the ice and more or less completely filled with glacial deposit, so that, instead of retaining the original regular slope of the preglacial valleys, the drift-filled valleys were frequently irregular, with numerous basins. In these, lakes, ponds and swamps now exist.

There are many different kinds of lakes resulting from glacial deposit. In some cases morainic dams have been built across streams. Again the dams are drumlins, or eskers, or sandplains, or kames. For some reason of supply or inability to transport, a greater load is deposited in one place than in another, and then of course a dam results. There is an almost infinite variety of possibilities here, and even careful study in the field will not always discover the exact reason for such dams. To this class of lakes belong many of those that beautify the scenery of the Adirondacks † (Fig. 9).

As has been stated above (p. 2), in the irregularities of the glacial deposits themselves, which may be considered to constitute *new* land, numerous lakes of original consequent origin are found. The most abundant of these are the ponds in the morainic kettles (Fig. 10); but very often kettles in the stratified drift deposits—

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* The consideration of these changes will be found in Article IV of this series, Bull. Amer. Geographical Soc., 1898, xxx, 206.

† In a paper just published, Kemp (Bull. 21, N. Y. State Museum) proves that Lake Placid is held in by a moraine dam, while other smaller lakes near by are in kettles in the moraine.

the kames, sandplains and overwash plains—are also found occupied by such ponds. In these sections, however, there are more basins than lakes, for frequently the basins have so small a drainage area to supply the water, or else are located upon so permeable a deposit of sand and gravel, into which the water sinks, that the basins cannot be filled to overflow (Fig. 10).

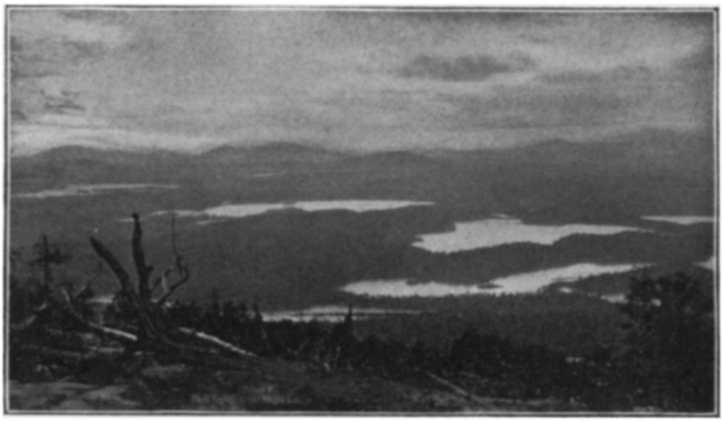

FIG. 9.—A GROUP OF GLACIAL LAKES IN THE ADIRONDACKS (S. R. STODDARD, PHOTOGRAPHER).

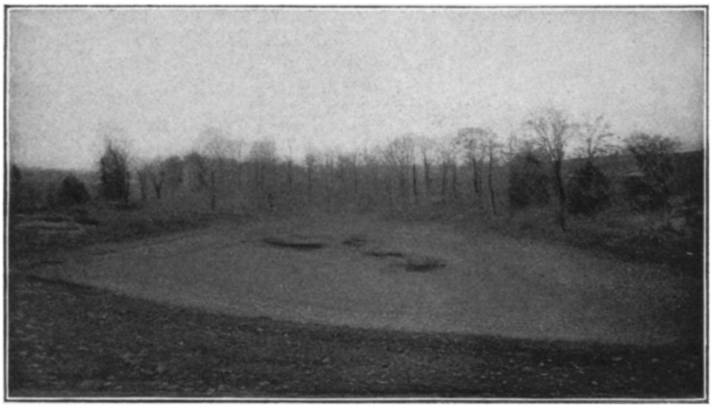

FIG. 10.—MARL BED OF A NEARLY DRIED-UP POND IN A KETTLE IN THE MORAINE NEAR CORTLAND, N. Y. (C. S. DOWNES, PHOTOGRAPHER.)

Another way in which the ice has been responsible for lake basins is by the erosive action of the glacier itself. Running water will maintain a fairly uniform slope, because it flows under the impulse of gravity; but rigid ice does not follow exactly the same laws. Either where the rock is softer, or the erosive power of the ice greater, a glacier may locally excavate more rapidly than elsewhere, and thus form a lake basin due to glacial erosion. Of these basins numerous instances have been found among mountains and in Greenland, where they abound. Doubtless in the State of New York there are many basins which are either entirely or partly caused by this erosive action. It is my belief that the basins of Lakes Cayuga and Seneca, and probably also Ontario, are in part due to glacial erosion (see p. 12).

SPECIFIC INSTANCES.—So little study has been given to the origin of New York lakes, that in most cases it is possible to make only such general statements as those above.

The Great Lakes, about which so much has been written, will serve as the topic for a future article of this series, so that for the present it will suffice to state that their origin is apparently complex. Pre-existing valleys have been dammed by glacial deposit, these valleys have in some cases been deepened by glacial erosion, and the lake form and depth have been essentially modified by the tilting of the land. This is quite generally agreed to be the origin of these lakes, although the relative importance of one or the other of these causes is not agreed upon.

Chautauqua Lake is very shallow and is considerably filled by stream deposits; its outflow at present is toward the south. The depth of the filling is not known; but, judging by the depth of the drift in other valleys in this section, it must be great. While it cannot be considered established, there is good topographic evidence in favor of the view that at least the northern end of the Chautauqua valley was in preglacial times tributary to the Lake Erie valley, the cause of the diversion being an extensive morainic deposit across this valley. There is a constriction of the valley near the middle of the lake, which suggests that this was the preglacial divide. If this view be true, Chautauqua Lake is made up of parts of two valleys, one north sloping, the other south sloping, and each dammed by heavy morainic accumulations.

In Central New York are a series of linear lakes, mostly located in north-sloping valleys. The two largest of these are Cayuga and Seneca. Each of these Finger Lakes owes its existence in part to glacial deposit, and, in the case of all but Cayuga and Seneca, this cause seems to be the important one for the basins. Without doubt they have all been modified by post-glacial uplift of the land, which was greater in the north than the south. Since this tilting is definitely established, it may be considered proved that the form and depth of these lakes have been modified by this cause.

In the case of Lakes Seneca and Cayuga, however, evidence has been brought forward* to show that they are in large measure due to glacial erosion; and doubtless future studies will discover other instances in which the same conclusion will be reached with reference to some of the Adirondack Lakes and probably basins in other parts of the State. There has been a prejudice against glacial erosion as an efficient means for carving rock basins, due, no doubt, in part to the extravagant claims made for this agency by Ramsay and his followers. Some even ignore the evidence brought forward in support of this cause; but when the final word has been written concerning the operation of ice in the erosion of basins, I predict that rock basin formation will be given a much more prominent position than some glacial geologists at present believe.

Aside from the Finger Lakes and Ontario,† the only other case that I am aware of in which glacial erosion is claimed as the cause for a lake in New York, is that of Lake Mohonk in the Shawangunk Mountains which Darton‡ ascribes in part to glacial deposit and in part, and probably pre-eminently, to glacial erosion.

Very little has been published upon Lake Champlain, but its markedly linear form and irregular outline suggest that it, together with Lake George, furnishes another illustration of a river valley clogged by a drift deposit, and modified by land tilting. In all probability also, the free passage of ice down this valley scoured out the valley bottom so that the basin is in part due to ice erosion. Its irregular form is the result of the entrance of the ponded water into tributary valleys of pre-glacial origin, forming bays and straits where the valleys existed, and promontories, islands and isthmuses where the land was higher.

An interesting case of a lake connected with the withdrawal of the ice sheet is described by Quereau.§ While the ice was withdrawing from this part of the country, temporary rivers flowed from the waters that were ponded back by the ice dam, forming glacial lakes. These rivers carved channels in places where now no rivers flow, and such channels are recognized south of Syracuse near Jamesville, as well as elsewhere. In one of these channels Jamesville Lake exists, occupying a pothole carved out at the base of a waterfall whose existence ceased when the ice barrier permitted the temporary stream to select another and lower channel. This is probably one of a type, other instances of which may be expected to be discovered as a result of future study. If Niagara should disappear, such a lake would exist at the base of the Horseshoe Falls.

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* See references, Bull. Amer. Geographical Soc., 1898, XXX, 396, in connection with which the question of origin of these lakes is also considered.

† Tarr, Bull. Amer. Geographical Soc., 1898, XXX, 53.

‡ State Museum Repts., Vol. 47, 1894, 540–552.

§ Bull. Geol. Soc. Amer., IX., 1898, 173–182.

LIFE HISTORY OF LAKES.—Even a large lake has a brief history when considered from the standpoint of geological time. A lake serves as an obstruction to a river, and this obstruction interferes with the river development. For the time being the stream cannot, at any place above the lake, lower its bed distinctly below the lake surface, so that the river at once sets about to remove the obstruction, commencing work at both ends of the lake, lowering the channel of outflow at the outlet, and attempting to obliterate the lake by filling, transforming it to dry land.

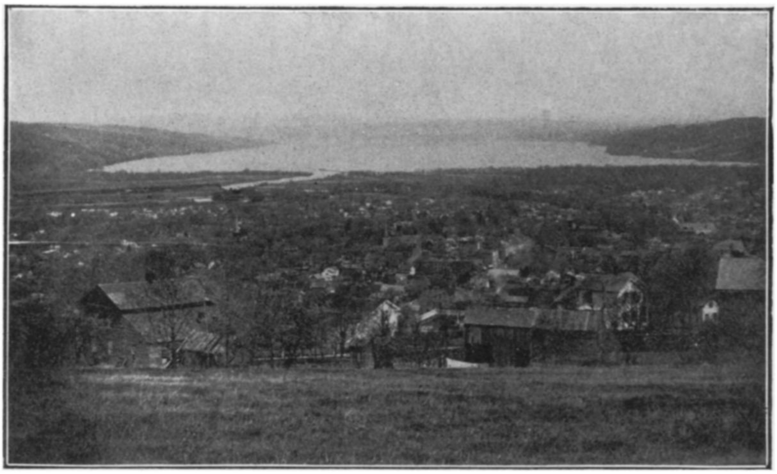


FIG. II.—INLET DELTA AT HEAD OF LAKE CAYUGA. CITY OF ITHACA SITUATED ON EAST SIDE OF DELTA.

Most lakes are destroyed by the combined work of cutting and filling, and this is the fate that awaits most of those in the world, even the largest. The main rivers, the thousands of tributaries, great and small, the temporary rainborn rills, the waves on the shore, and the wind from the land, are all at work carrying fragments of rock waste from the land to the lake. The contributions of a single day or a single year may not be great; but after centuries and scores of centuries, the cumulative effect of those minute contributions is felt.

Naturally most of the rock waste is furnished by the largest streams, and of this the coarsest, and in fact the greatest measure, is deposited at the very mouth of the streams, forming deltas which constantly grow out into the lake, and will ultimately fill it in combination with the other agents of filling (Figs. 11 and 13). A large stream bearing sediment from one side may build a delta which temporarily bisects the lake (Fig. 12), or, as at Interlaken, in Switzerland, two such deltas from opposite sides may accomplish the same end. During the process of lake filling there may be a great variety of stages.

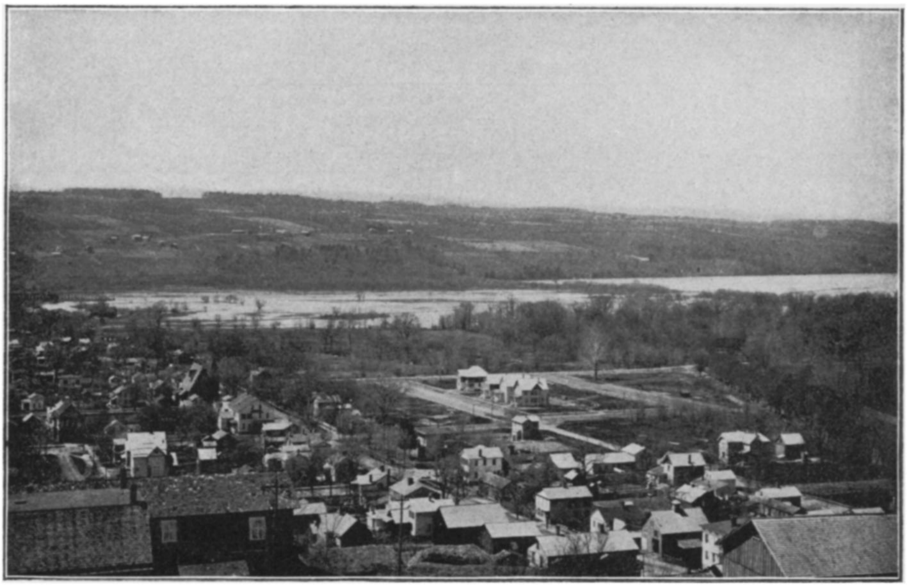


FIG. 13.—TEMPORARILY FLOODED WESTERN PORTION OF INLET DELTA AT HEAD OF CAYUGA LAKE, N. Y.

The ultimate end, therefore, is destruction by filling, provided no other processes of destruction enter to check this. It may happen, to be sure, that the outlet stream cuts away the barrier faster than the lake is filled, and then the waters are drained off from the deltas and even from the lake bottom. This mode of destruction will usually occur only where the outlet barrier is a soft deposit, such as glacial till, that is easily removed. Even then there must be considerable slope for the outlet stream. Usually such an outflow stream possesses little power of erosion, because most of the sediment has been filtered out by the lake waters, and the stream therefore emerges clear and free from the cutting tools

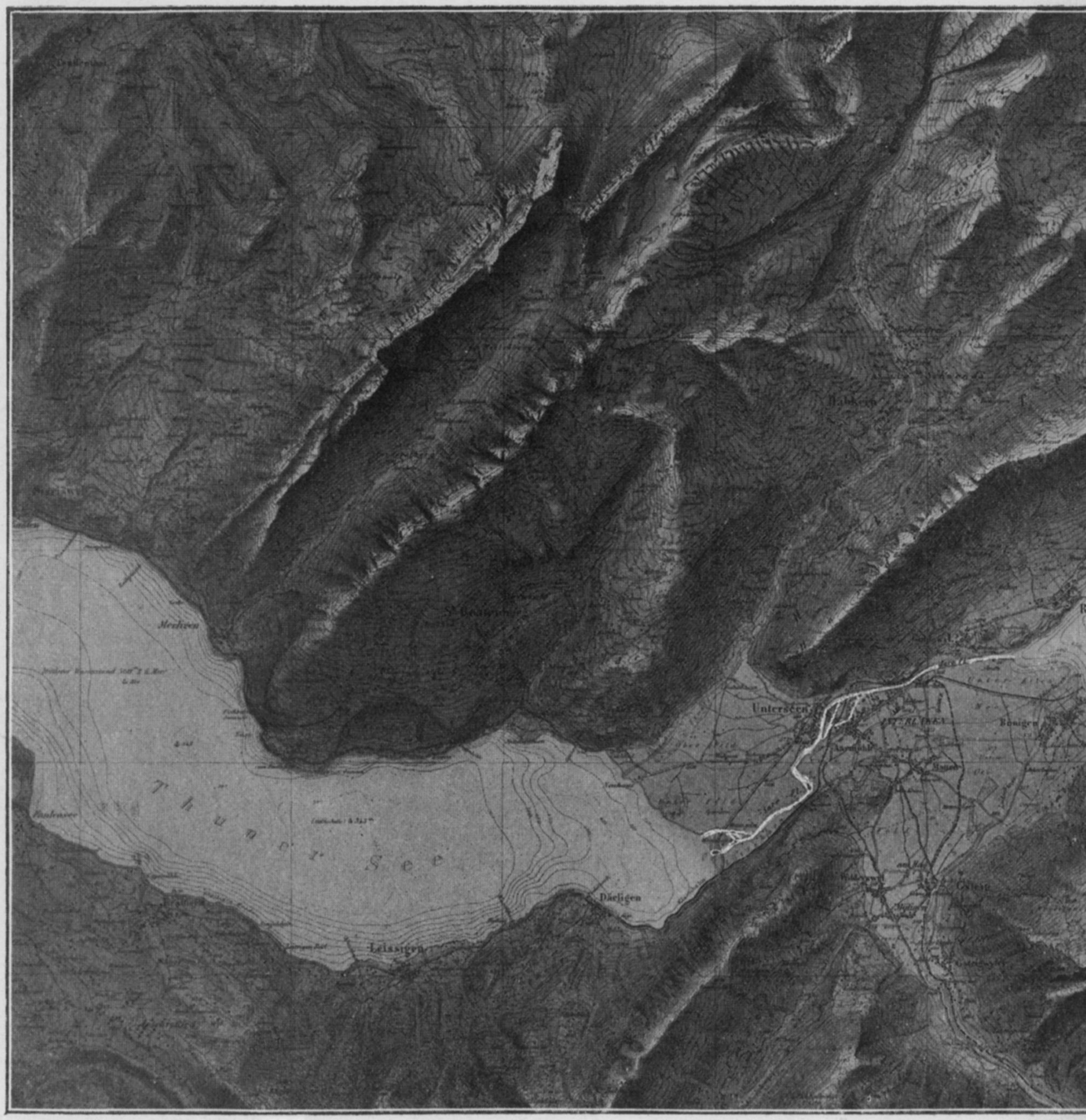
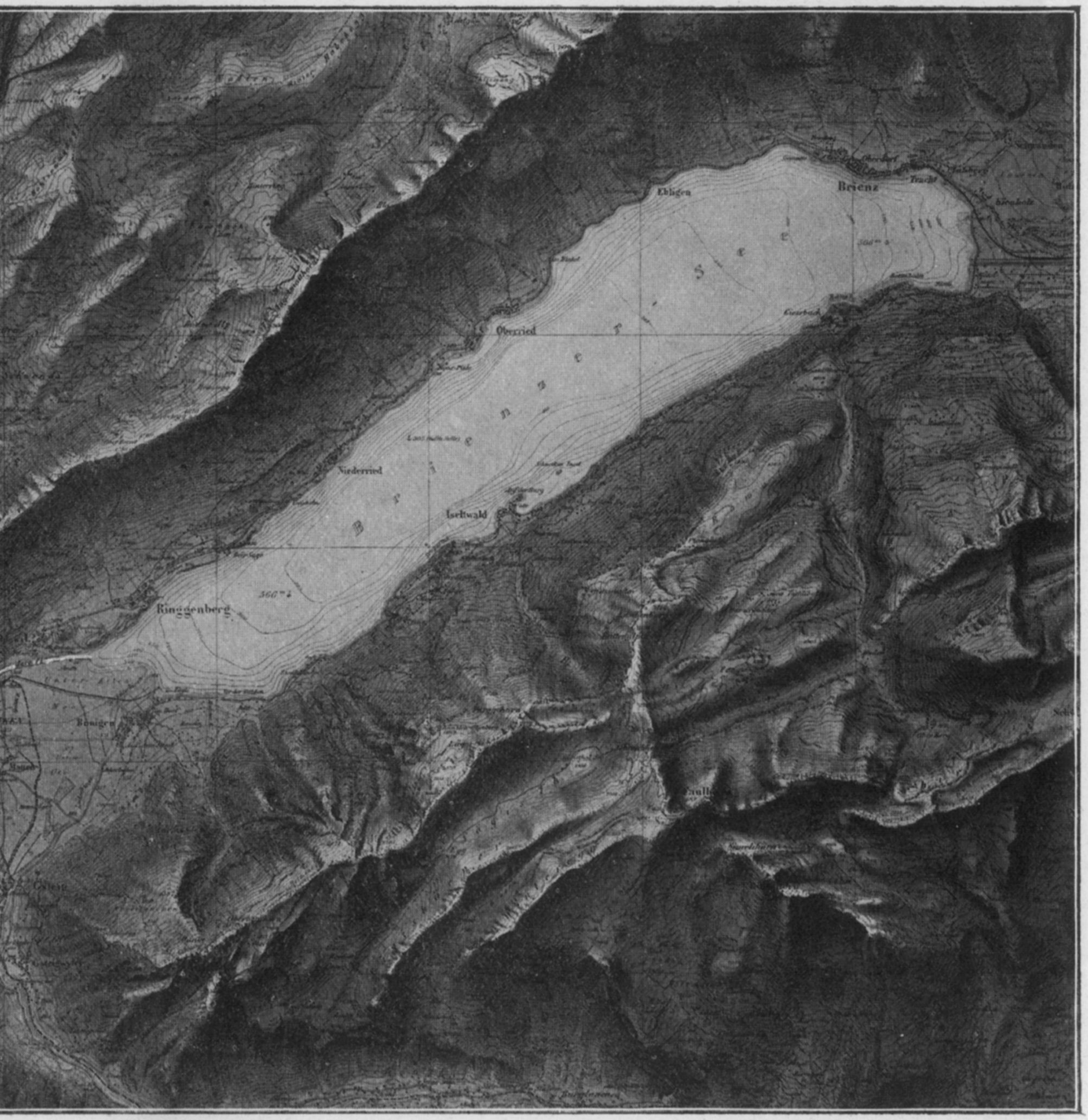


FIG. 12.—MAP OF VICINITY OF INTERLAKEN REGION, SHOWING BISECTION OF



VING BISECTION OF LAKE BY GROWTH OF DELTA (SWISS TOPOGRAPHIC MAP).

with which most streams are enabled to scour out channels even in hard rock.

If for any reason the power of the outlet stream becomes sufficiently concentrated, even though it has little sediment, it may work effectually to lower the barrier. For instance, Niagara River, which is scarcely cutting at all in its channel above the cataract, is at work at the Falls at such a rate that they have already retreated several miles, and are each year moving nearer Lake Erie. If they could ever be able to reach the lake, there would then come a sudden drop in the lake level.

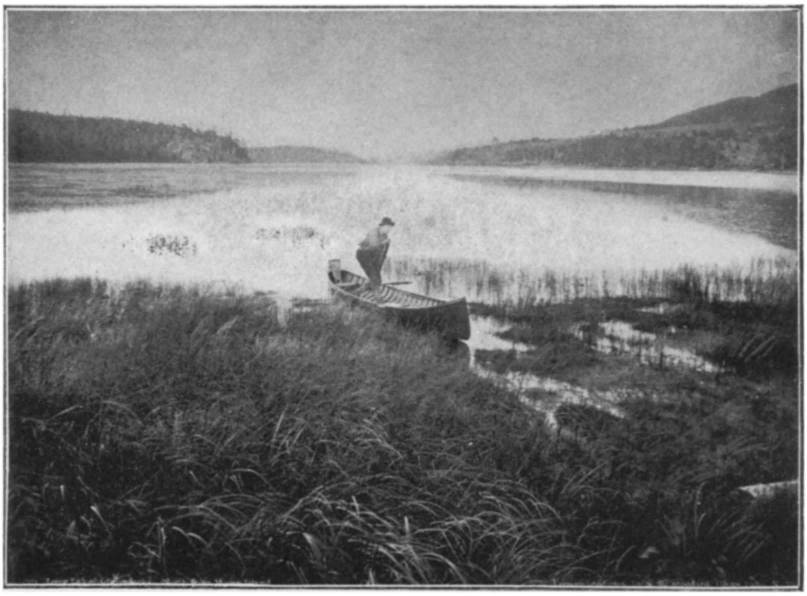


FIG. 14.—SWAMPY SHORE OF LONG LAKE, ADIRONDACKS (COPYRIGHT, 1888, BY S. R. STODDARD, GLENS FALLS, N. Y.).

With the filling of a lake, vegetation often has much to do (Figs. 14–19). As soon as the water in one place becomes shallow enough. lacustrine vegetation takes root and in time transforms this section to a swamp. The delta margins are among the first to become thus transformed.

For instance, at the southern or inlet ends of Lakes Cayuga and Seneca, as well as of some of the other Finger Lakes, extensive delta deposits have been accumulated from the waste obtained in the erosion of the post-glacial gorges. The depth of the delta-filling in some cases amounts to 200 or 300 feet, and the surface is nearly level, because it is primarily determined by the plane of the lake surface. These level tracts, reaching slightly above the water, are naturally swampy, particularly near the lake shore, and the same is true of some of the small deltas that are being built along the margin of these lakes opposite the gorges, as, for example, opposite Taughannock. These marginal delta swamps are not so extensive in Lake Cayuga as they are along the shores of Chautauqua Lake, because the depth of water to be filled is so much greater in Cayuga than in the shallow Chautauqua. Opposite the mouths of all the larger streams entering Chautauqua Lake there are broad and very swampy delta tracts.

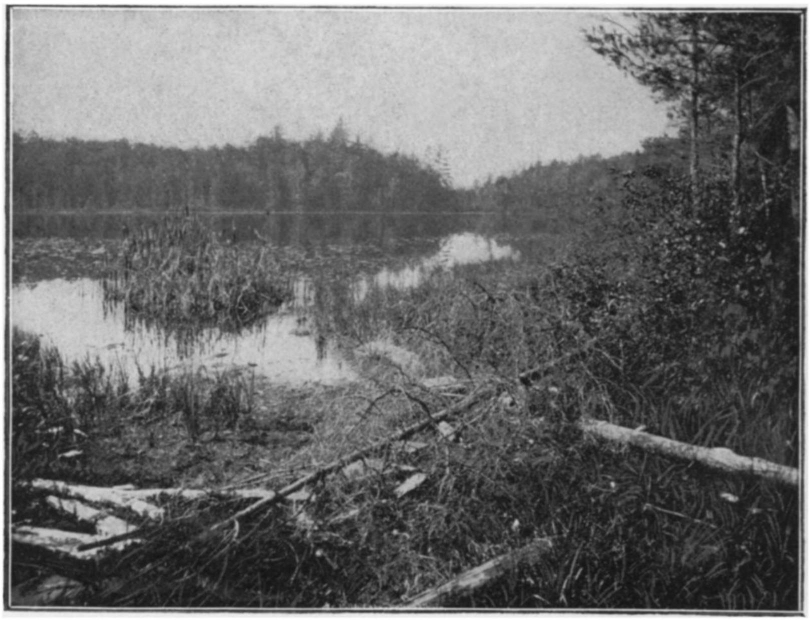


FIG. 15.—SWAMPY SHORE OF FIFTH LAKE, FULTON CHAIN, ADIRONDACKS (S. R. STODDARD, PHOTOGRAPHER).

The delta plains near the head of Lakes Cayuga and Seneca are most swampy on the side where the sediment supply is least abundant, that is, on the western side in the case of Cayuga, and on the eastern side in the case of Seneca. This has had an important influence in determining the location of the two towns of Ithaca and Watkins (Figs. 11, 13 and 17).

Accumulation of rock débris in the lake will in time do more than form deltas opposite the stream mouths. It will eventually fill up the lake.* This filling is aided in its last stages by vegetation. The reeds, the lily pads, the sphagnum moss, and other water-loving plants, transform the shores to swamps, and finally may reach over the entire surface, forming a broad swamp in place of the lake (Fig. 19), at first not dry enough for trees, but later transformed to a tree-covered swamp. In these swamps peat is formed,† and there are thousands of filled ponds and lakes of this origin in the State.

In some cases, before the vegetable deposit is formed in excess, there are conditions favoring the accumulation of layers of animal remains. First sediment finds its way into the pond freely, then, the shores becoming swampy, the sediment is commonly arrested in its course near the margin, so that the shells of animals may accumulate more rapidly than either the rock fragments or the vegetable remains. In such a case layers of shells are formed, and

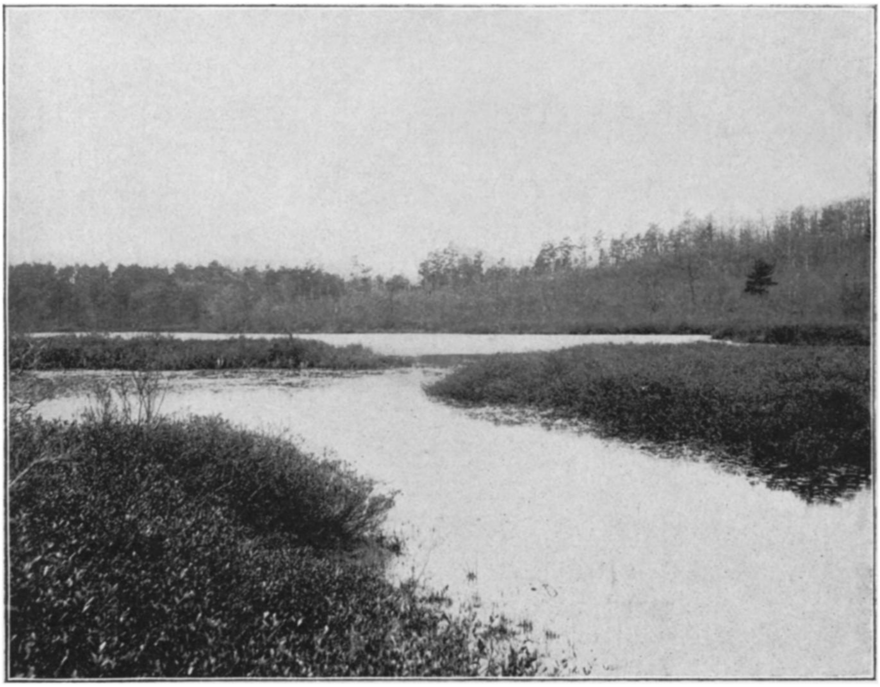


FIG. 16.—SWAMPY SHORE OF CLAY POND, BOURNE, MASS. (J. L. GARDNER, 2ND PHOTOGRAPHER).

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* Smyth, A. Geol., 1893, XI, 85–90.

† Mather, Geol. of New York, 1st Dist., 1843, 12–16, 229–32; Vanuxem, Same, 3rd Dist., 1842, 229–31.

after this, with the encroachment of vegetation, plant remains accumulate in excess. In such places we find first a layer of clay, representing a time of deposit of sediment, then of animal remains, such as marl (Fig. 10) or infusorial earth (including the tests of diatoms), and above this is a bed of peat. Hundreds of sections similar to this have been revealed in various parts of New York, the best with which I am acquainted being those at the cement works at Casadaga Lake in Chautauqua County. Here the lakes are not entirely filled, but during the process of filling have been divided into several lakes and swamps, so that every stage in the lake destruction may be seen.

Such conditions as these are best found where the sediment supply is slight. In some places there is so little clay and sand furnished that the organic deposits are most prominent. For instance, some of the ponds occupying kettles in the moraine near Cortland have such a slight drainage area that they receive so little sediment that their beds are made exclusively of a marl (Fig. 10), which is so abundant that it is removed for use.

Elsewhere the lake filling is mainly accomplished by vegetation from first to last, because almost no sediment is supplied. This is illustrated in the case of ponds and swamps in the wooded region of the Adirondacks and in the tiny kettle ponds in parts of the moraine; but on a larger scale it is illustrated in the lakes and swamps of southern Florida, where the streams bring almost no sediment, and the lakes are being changed to swamps by an accumulation of vegetable muck which in places is several feet thick. Such deposits as these may be considered as embryonic coal beds.

Thus sediment filling, aided by plant and animal deposit, is engaged in the extermination of lakes, and the first result is the formation of swampy land. In this State there are instances of every stage of lake filling from the beginning to the end. Later the swamps will be drained by natural processes, for the streams are then able to flow across the deposits (Fig. 19), and thus help to drain and to excavate them, so that finally the swampy tracts are transformed to dry plains drained by the very streams that helped to form them. In time all the lake deposits will be removed from a valley, and this completes the life history of the lake. Of this process of removal of lake deposits there are instances in this State, though in most cases the time since the glacial period, when the lakes were formed, has been so brief that filling is generally incomplete.

Not all lakes pass through this normal cycle of development; some are subjected to accident by which they are removed. For instance, a lake held behind an ice dam will disappear, when, by melting, this dam is removed. Such has been the history of the ice-dammed lakes of New York. With so insecure a dam such lakes are very uncertain, as one may plainly see along the ice margin of Greenland, where in a single season lakes form and disappear.

Another cause for disappearance of lakes by other than the normal processes is when the climate changes from moist to dry. If, for example, the climate of the Great Lakes should change to one of aridity, they would gradually shrink until they were disconnected, and this shrinking might continue either until the basins became dry areas of interior drainage, or were occupied by shallow lakes, saline in character through the concentration of the salts furnished by the water, but no longer removed by overflow, and incapable of being removed by evaporation.

Such a condition as this exists in many arid lands, notably in Central Asia and our western interior basin, in which one of the basins holds the Great Salt Lake. While this condition is now absent from New York, the presence of extensive beds of Silurian salt suggests the possibility that, at this early period, the supposed conditions actually did exist within the confines of the State; and in the changes of climate which have occurred since then, of which we feel certain that there have been many, though we cannot specify each of them, and point out its effects, there may well have been similar changes in later periods; indeed others still may be in store.

SWAMPS.—There are various ways in which swamps may be formed; but perhaps the commonest swamp in New York is that caused where underground water escapes to the surface on a hillside, or at the base of a hill, and finds its run-off retarded, either by the growth of vegetation, or by the levelness of the ground. With the removal of the forests, many swamps of this kind have disappeared, and their site is marked by the presence of a dark carbonaceous soil. In other cases the supply of water is so great that the mere removal of trees is not sufficient to drain the surface; and then, in some instances, artificial drainage has been resorted to.

Swamps of this kind, although abundant, are small. They are found in great numbers in the morainic country, where the water readily percolates through the stratified drift, but is retarded, and even forced to escape to the air, when it reaches the more compact underlying boulder clay. Sometimes a linear swamp is then formed along a part of the base of a hill; or sometimes the water seeps out of the soil on a hillside, where, by a little excavation, a spring can be made. The swamp-loving vegetation, the sphagnum, etc., grows abundantly here, and spreads, finally causing a small hillside swamp. In the damp climate of Scotland and Ireland, the sphagnum bogs at times become so saturated with water that they commence to flow down the hillside, often causing considerable destruction.*

Long linear swamps are also formed in many places along the base of the beaches that were built when the waters of the Great Lakes stood at a higher level. The rain soaks down into the gravel, but is not able to so easily enter the underlying clays. Such swamps as these abound along the north faces of the beaches formed during the high stage of Lake Erie in Chautauqua County.

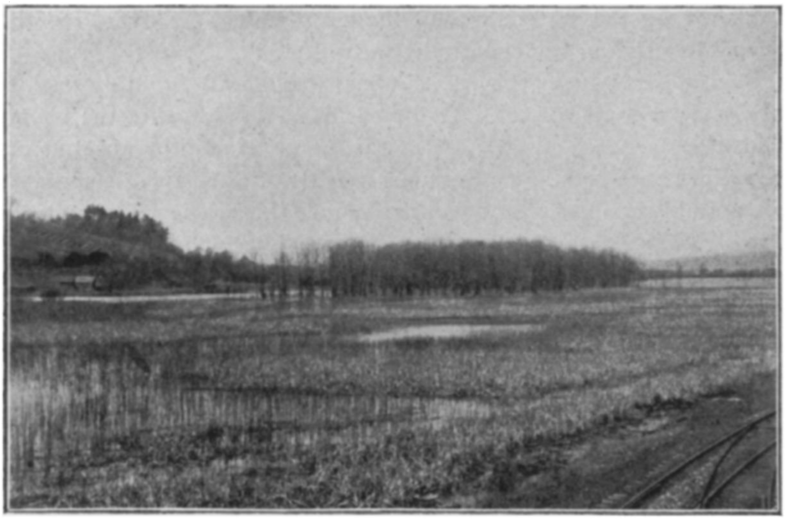

FIG. 17.—SWAMPY PORTION OF INLET DELTA, HEAD OF CAYUGA LAKE (C. S. DOWNES, PHOTOGRAPHER).

Swamps, often of a temporary nature, are formed on the floodplains of the New York rivers; but they are commonly dried up shortly after the river floods have subsided. Such swamps may be seen along the Upper Mohawk where that river is flowing over the level plain of the old lake bottom. These swamps, on a small scale, are the counterpart of the great swamps of large floodplains, like those of the Mississippi, the Yellow, etc.

Of the *large* fresh-water swamps, which are very abundant, the great majority are connected with some part of a lake history. For instance, a bay, either on sea or lake shore, becomes shut in by bars, and, upon being filled, is changed to a swamp. Or, even without an enclosing bar, a bay along a lake shore may become a fresh-water swamp by mere filling as the result of the sediment brought by tributary streams. The filling of any lake or pond will in time produce a swampy tract (Figs. 13–19). This process of lake filling, together with the production of delta, lake shore and filled-lake swamps, has already been sufficiently described.

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* See Früh, Viertel. Naturfors. Gesells., Zürich, 1897, XLII, 202–237.

Another class of lake swamps is that formed in connection with the disappearance of the ice. During the stand of the glacier, the temporary lakes received deposits which were spread out with such levelness that swamps now exist on parts of the sites of many of them. Conewango swamp, in Chautauqua County, is situated in the bottom of an extinct lake, formed while the glacier was standing in that region. Although the lake has now disappeared, its presence is marked by shore lines on the neighboring hillsides.

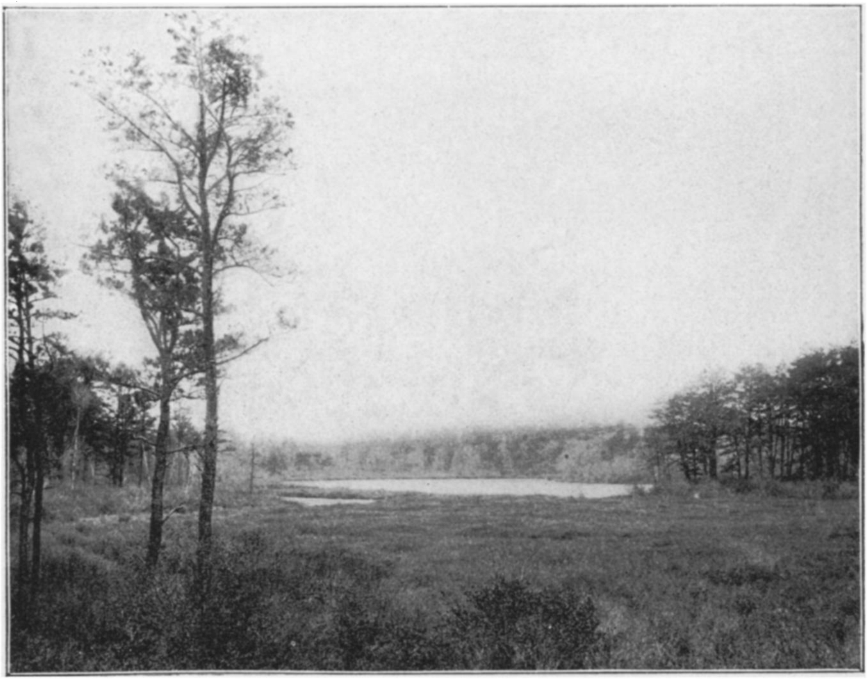

FIG. 18.—SWAMP REPLACING POND, CLAY POND, BOURNE, MASS. (J. L. GARDNER, 2ND, PHOTOGRAPHER.)

The Montezuma marshes, at the outlet of Lake Cayuga, also appear to be associated in origin with the withdrawal of the ice sheet. One expects to find swamps at the *head* of lakes, where filling is in operation ; but the *outlet* should not normally be the seat of an extensive swamp, as is the case in Lake Cayuga. It is known that the ice stood in this region for a while, building moraines and evidently pouring sediment into the lake from streams issuing from its front. This sediment, entering a body of quiet water, naturally spread itself out in the form of a moderately level sheet. This shallowed the northern end of Lake Cayuga, so that in post-glacial times it has become transformed to an extensive swamp, chiefly through the agency of vegetation, which has added the top layer.

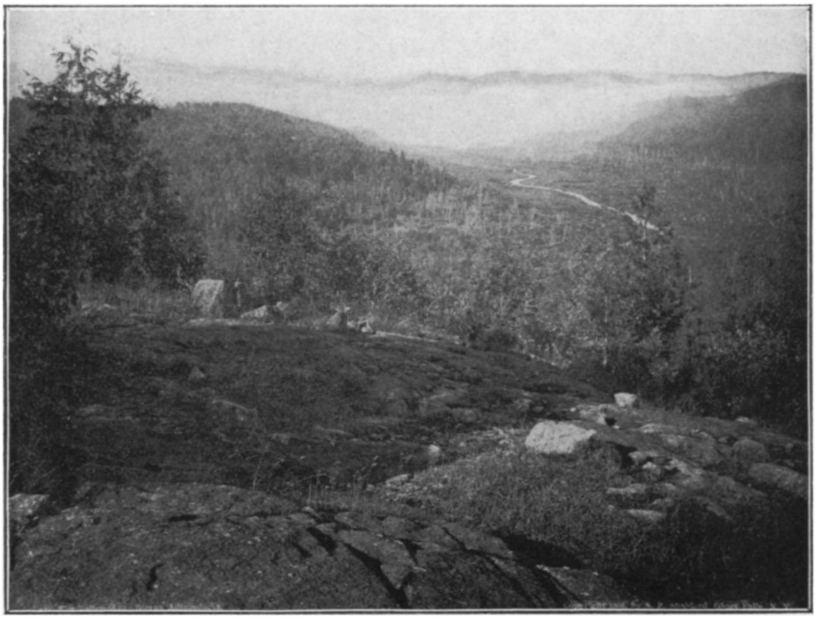

FIG. 19.—VALLEY OF THE BOREAS, ILLUSTRATING SWAMP FORMED BY LAKE FILLING (COPYRIGHT, 1888, BY S. R. STODDARD, GLENS FALLS, N. Y.).

This swamp is even now encroaching southward upon the lake, which is shallow near the outlet end, where the clear lake water merges imperceptibly into the reed-covered swampy tract.

Gilbert* has brought forward evidence that the land in the Great Lakes region is still rising, tilting the land by raising it more in the north than in the south, and geological evidence points to the conclusion that it has been rising in the recent past. This tilting of the land has necessarily diminished the slope of north-flowing streams, and should tend to increase the swampiness of the lake deltas on the southern end of the Finger Lakes. Concerning such tilting Shaler * has suggested that the swampiness of one of the New England valleys, the Nashua, has resulted from this tilting, and it is not improbable that some swamps in New York are of the same origin. The swampy tracts along portions of the Champlain shore may be due to this rising change in level of the land.

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* Nat. Geog. Mag., 1897, VIII, 233–247; Eighteenth Ann. Rept. U. S. Geol. Survey, 1898, 595–647.

By far the most extensive swamps are those produced by the elevation of level sea bottoms. Drainage upon them is at first so poorly developed that they are swampy, as in the case of the elevated sea bottom of southern Florida and eastern Texas. Later, as the streams sink their channels into these level tracts, they become drained, as has been the case with the pine land plains of New Jersey.

There are no such sea-bottom swamp plains in New York, though during the elevation of the Appalachians, their western face, even in New York, was skirted by plains which at first were undoubtedly swampy, similar to those upon which the coal fields of Pennsylvania developed. These have now been transformed by elevation and dissection to the central New York plateau, from which many of the overlying layers have been stripped, so that it is not impossible that the evidence of this swampiness, in the form of coal beds, which may once have existed, has been removed in the course of denudation.

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* Amer. Jour. Sci., 1887, XXXIII, 210–221.